THE ARMY
BEHIND THE ARMY

THE BURNING OF AN OBSERVATION BALLOON AT FORT SILL, OKLAHOMA.

THE ARMY BEHIND THE ARMY

BY

MAJOR E. ALEXANDER POWELL

U. S. A.

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TO

FIVE FRIENDS OF THE A. E. F.

LIEUT.-COL. N. J. WILEY
MAJOR HUGH B. ROWLAND
MAJOR HAMILTON FISH, JR.
LIEUT. WILFORD S. CONROW
LIEUT. KINGDON GOULD

IN MEMORY OF THE DAYS WE SPENT TOGETHER
ON THE BANKS OF THE MARNE

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For the interest they have shown and the assistance they have given me in the preparation of this book, I am indebted to many persons. Each chapter was written with the co-operation of the chief and subchiefs of the branch of the army with which it deals, and upon its completion it was by them carefully read and revised. The statements and figures are as nearly accurate, therefore, as extreme care can make them. The Honorable Newton D. Baker, Secretary of War, authorized the writing of the book and issued orders that every facility was to be afforded me for obtaining the necessary material, and the Honorable Benedict Crowell, Assistant Secretary of War, who from the beginning took a lively personal interest in the work, placed at my disposal the great mass of material which he had collected for his Official Report. To Major-General William S. Seibert, Director of the Chemical Warfare Service, to Colonel William S. Walker, in command of Edgewood Arsenal, and to Colonel Bradley Dewey, in command of the Gas Defense Division, I am particularly indebted, as it was due to their efforts that I was able to undertake the writing of the book. Major-General William M. Black, Chief of Engineers, Lieutenant-Colonel Chenoweth, and Major Evarts Tracy of the Corps of Engineers; Major-General C. T. Menoher, Director of Military

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THE EARS OF THE ARMY

BEFORE the war made most Americans as conversant with the functions of the various branches of the army as they are with the duties of the gardener and the cook, the work of the Signal Corps troops was popularly supposed to consist, in the main, of standing in full view of the enemy and frantically waving little red-and-white flags. Don't you remember those gaudily colored recruiting posters which depicted a slender youth in khaki standing on a parapet, a signal-flag in either outstretched hand, in superb defiance of the shells which were bursting all about him? This popular and picturesque conception was still further fostered at the officers' training-camps, where the harassed candidates spent many unhappy hours attempting to master the technic of semaphore and wigwag. Yet, as a matter of fact, during more than four years of war I do not recall ever having seen a soldier of any nation attempt to signal by means of flags, save, perhaps, in the back areas. Had such an attempt been made under battle conditions the signaler probably would have provided, in the words of the poet, "more work for the undertaker, another little job for the casket-maker."

By this I do not mean to imply that the changed conditions brought about by the Great War made

the army signaler a good life-insurance risk. Far from it! But they did have the effect of making him a trifle less dashing and picturesque. Instead of recklessly exposing himself on the parapet of a trench in order to dash-dot a message which the enemy could have read with the greatest ease, he dragged himself, foot by foot, across the steel-swept terrain, a mud-caked and disreputable figure, on his task of repairing the tangle of copper strands which linked the infantrymen in the front-line trenches with the eager guns; crouching in the meagre shelter afforded by a shell-hole, with receivers strapped to his ears, he sent his radio messages into space; carrying on his back a wicker hamper filled with pigeons, he went forward with the second wave of an attack; or, by means of a military edition of the dictaphone device so familiar to readers of detective stories, he eavesdropped on the enemy's strictly private conversations. Even though he had no opportunity to wave his little flags, the Signal Corps man never lacked for action and excitement.

If the Air Service is, as it has frequently been termed, "the eyes of the army," then the Signal Corps constitutes the army's entire nerve-system. Under the conditions imposed by modern warfare, an army without aviators would be at least partially blind, but without signalers it would be bereft of touch, speech, and hearing. It is the business of the Signal Corps to operate and maintain all the various systems of message transmission — telegraphs, telephones, radios, buzzers, Fullerphones, flags, lamps, panels, heliographs,

pyrotechnics, despatch-riders, pigeons, even dogs—which enable the Commander-in-Chief to keep in constant communication with the various units of his army and which permit of those units keeping in touch with each other. It was imperative that General Pershing should be able to pick up his telephone-receiver in his private car, sidetracked hundreds of miles away from the battle-front, perhaps, and talk, if he so desired, with a subaltern of infantry crouching in his dugout on the edge of No Man's Land. The Secretary of War, seated at his desk in Washington, must be enabled to talk to the commander of a camp on the Rio Grande or of a cantonment in the Far Northwest. Though every strand of wire leading to the advanced positions was cut by the periodic shell-storms, means had to be provided for the commanders of the troops holding those positions to call for artillery support, for reinforcements, for ammunition, or for food. It was essential to the proper working of the great war-machine that the chiefs of the Services of Supply at Tours should be in constant telegraphic and telephonic communication with the officers in charge of the unloading of troops and supplies at Bordeaux and Marseilles, at Brest and St. Nazaire. It was vital that the Chief of Staff should be kept constantly informed of conditions at the various ports of embarkation. All this was made possible by the Signal Corps. But it was also necessary that these various conversations should be so safeguarded that there was no possibility of them being overheard by enemy spies. And the Signal Corps saw to that too.

When Count von Bernstorff was handed his passports in the spring of 1917, the Signal Corps consisted of barely 50 officers and about 2,500 men. When, nineteen months later, the German delegates, standing about a table in Marshal Foch's private car, sullenly affixed their signatures to the Armistice, the corps had grown to nearly 2,800 officers and upward of 53,000 men. It comprised at the close of the war seventy-one field signal battalions, thirty-four telegraph battalions, twenty replacement and training battalions, and fifty-two service companies, together with several pigeon and army radio companies, a photographic section, and a meteorological section.

Not many people are aware, I imagine, that nearly a third of the officers and men who wore on their collars the little crossed flags of the Signal Corps were recruited from the employees of the two great rival telephone systems of the United States—the Bell and the Independent. The former raised and sent to France twelve complete telegraph battalions; the latter ten field signal battalions—to say nothing of the great number of experts, specialists, and telephone-girls who left the employ of those systems to embark on the Great Adventure. So you need not be surprised if, the next time your telephone gets out of order, your trouble call is answered by a bronzed and wiry youth who wears in the buttonhole of his rather shabby coat the tricolored ribbon of the D. S. C.—won, perhaps, while keeping the communications open at Château-Thierry. And the operator who says, "Number, please," so sweetly, may have been—who knows?—one

of those alert young women in trim blue serge who sat before the switchboard at Great Headquarters and handled the messages of the Commander-in-Chief himself.

For a number of years before the war it was recognized in Washington that should the United States ever become involved in a conflict with a first-class Power, the handful of officers and men who composed the personnel of the Signal Corps would be utterly incapable of handling, unaided, the enormous system of communications which is so essential to the success of a modern army. It was perfectly evident, moreover, that should the country suddenly find itself confronting an emergency, there would be no time to train officers and men in the highly technical requirements of the Signal Corps. To insure the success of the great citizen armies which we would be compelled to raise with the utmost speed in case of war, it was essential that there should be available an adequate supply of men who were already thoroughly trained in the installation and operation of the two chief forms of military communication—telegraphs and telephones. And this trained personnel was at hand in the employees of the great telephone and telegraph companies. It was not, however, until June, 1916, when Congress, tardily awakening to the imminent danger of sparks falling on our own roof from the great conflagration in Europe, passed the National Defense Act, which authorized, among other things, the creation of the Signal Officers' Reserve Corps and the Signal Enlisted Reserve Corps, that the way was opened for

definite action. Shortly thereafter the Bell Telephone System was approached by the Signal Corps with the suggestion that a number of reserve Signal Corps units be recruited from its various subsidiary organizations. The suggestion met with the hearty approval of the Bell officials and the work of organization was turned over to the Bell's chief engineer, Mr. J. J. Carty, the foremost telephone expert in the world. In accordance with the plans drawn up by Mr. Carty, there were organized from the employees of the New York, New England, Pennsylvania, Chesapeake and Potomac, Central Union, Cincinnati, Northwestern, Southwestern, Southern, Mountain States, and Pacific telephone companies twelve reserve telegraph battalions. I might mention, in passing, that Mr. Carty was given a commission as major, was later promoted to colonel, was made chief of the telegraphs and telephones of the A. E. F., and for his invaluable work was awarded the Distinguished Service Medal.

While the Bell System was devoting its efforts to the raising of the telegraph battalions, the Chief Signal Officer of the Army asked the co-operation of the Bell's great rival, the United States Independent Telephone Association, in the organization of a number of field signal battalions for front-line work. Mr. F. B. McKinnon, vice-president of the association, assumed charge of the work and enthusiastically threw himself and all the agencies at his disposal into the business of recruiting, ten field battalions eventually being raised by the Independent System.

But the demand for trained personnel from the

telegraph and telephone companies did not end with the formation of the units I have just mentioned. With the declaration of war and the despatch to France of the first American contingents, it was realized that their work had only begun. Though the telegraph and field battalions contained many experts on telegraphy and telephony, they were formed primarily as constructive and operative units for comparatively short lines. But the lines in the A. E. F. did not remain short, and as they grew in length and in number, new equipment and different types of technicians had to be employed. In August, 1917, there came from France the first call for specialists, to include telephone-repeater experts, printer-telegraph mechanicians, printing-telegraph traffic supervisors, and similar highly trained men. Almost at the same time there was received a cablegram from General Pershing requesting the immediate organization in Paris of a Research and Inspection Department, in order that the best, latest, and most reliable signal equipment might be assured for the American troops. To Colonel Carty was assigned the task of selecting the twelve scientists to be the officers of the new division and the fifty enlisted assistants who were necessary to commence the work. He found them in the remarkable Research Department of the Western Electric Company, which is closely allied with the Bell System, Mr. Herbert Shreeve of the Western Electric being given a commission as lieutenant-colonel and placed in charge of the work. The improvements made and the devices introduced by this division made the signal

system of the A. E. F. one of the marvels of the war. So wide-spread and reliable were the American communications, and so efficient the American operators, that on more than one occasion Marshal Foch, during his tours of inspection along the battle-front, went many miles out of his way in order to use the American wires for important conversations. But so rapid was the growth of the telegraph and telephone lines in France that hardly had one requisition for additional personnel been filled before another was received. Yet always the great systems of the United States answered the call, and this despite their crying need for such personnel at home, where war conditions had enormously increased their business, and the difficulty which they were experiencing in making replacements in their own forces. In fact, of the 2,800 officers commissioned in the Signal Corps during the war, fully 30 per cent had been trained with the telegraph and telephone systems, and the percentage of enlisted men was equally high. The response made by these great corporations to the nation's call constitutes, indeed, one of the most gratifying incidents of the war.

When the history of the great conflict comes to be written, the story of the achievements of the telegraph and field battalions of the Signal Corps will form one of its most fascinating chapters. Working under the most trying conditions, in a land with whose customs they were unfamiliar and whose language they did not understand, with equipment and material frequently improvised from whatever was at hand, they covered

Photograph by Signal Corps, U. S. A.

LAYING A FIELD TELEGRAPH LINE.

They established a standard of speed and efficiency.

SIGNAL CORPS MEN ERECTING A FIELD TELEPHONE.

Working under the most trying conditions, these men covered France with the network of wires.

SIGNAL CORPS MEN AT WORK REPAIRING THE TANGLE OF COPPER WIRES WHICH LINK THE INFANTRY IN THE FRONT-LINE TRENCHES WITH THE GUNS.

France from the seaboard to the Rhine with the network of their wires; they made it as easy for Great Headquarters to communicate with a remote outpost in Alsace or the Argonne as it is for a brokerage house in Wall Street to communicate with the manager of its Chicago branch, and it established a standard of speed and efficiency which will make the French dissatisfied with their own services for years to come. Their work was, in the words of General Pershing, "a striking example of the wisdom of placing highly skilled technical men in the places where their experience and skill will count the most."

Despite the unending stream of men which constantly flowed Europeward for work on the "A. E. F. Tel. & Tel. Co.," as our military telegraphs and telephones were familiarly known, more were ever needed, and it was finally decided, though, I believe, with considerable reluctance on the part of certain old-fashioned officers in the War Department, to replace the men operators, wherever possible, with girls. Again the American systems were called upon, this time to furnish young women who possessed the necessary technical experience, and to give them a working knowledge of French. Imagine the furor of excitement that swept through every telephone-exchange in the country when it was learned that girls were wanted for service in the A. E. F! Where was the red-blooded, adventure-loving American girl who could resist such a call? Soon the company officials as well as the Signal Corps itself were almost swamped by the flood of applications that poured in. Then the Signal Corps found itself

confronted by the necessity of educating the applicants; to do this it had to operate a whole system of boarding-schools for girls. Such schools were established in New York, Philadelphia, Chicago, San Francisco, Jersey City, Atlantic City, and Lancaster, Pa., the candidates for overseas duty being given intensive courses in military telephony, French, and European geography, together with lectures on French manners and customs, and, I might add (this in a whisper), on their own behavior, particular emphasis being laid on the evils of flirting, impertinence, and gum-chewing. Upward of 200 girls were finally selected, provided with uniforms and overseas caps of navy serge—which looked as though they might have been designed by the technical experts of the Signal Corps—and sent to France as full-fledged members of the A. E. F. No pupils at a fashionable girls' boarding-school were ever more strictly chaperoned. At Tours quarters were built for them on an island in the Loire, which was connected with the mainland by a narrow foot-bridge, the military police on duty at the end of the bridge only permitting the girls to "go ashore" when they were accompanied by a matron or were in pairs. Notwithstanding the strictness of the regulations under which they lived and worked, it was a girl's own fault if she came home unengaged. Though it goes without saying that the military authorities took every precaution against exposing the girls to danger, those who were on duty in towns near the front, such as Toul, on numerous occasions tasted the excitement of German air-raids, one of them being cited in army orders for

remaining at her post and coolly continuing to operate her switchboard "whence all but she had fled."

I always liked the true story of the telephone-girl who, upon her arrival at an American port of debarkation, informed the landing officer that she was a second lieutenant.

"But why do you call yourself a second lieutenant?" he inquired. "No commissions have been given to telephone-girls."

"I don't see what that's got to do with it," she retorted, tossing her head. "I get more pay than a second lieutenant, and I've been of more use to the army than any second lieutenant that I know."

In order to assess at their true worth the achievements of the Signal Corps during the war, it is essential to realize the amazing number, variety, and magnitude of the tasks the corps was called upon to perform. The Signal Corps is a staff department charged with providing means of communication for the army, both at home and overseas. According to the present tables of organization, one field signal battalion is usually attached to each division, the telegraph battalions being used as corps or army troops. Generally speaking, the telegraph battalion maintains communications in the rear; the field battalion usually operates with the combat troops at the front. In addition to these troops, there are numerous special units, such as pigeon companies, radio companies, photographic and meteorological sections, which are attached to corps, armies, or to General Headquarters. In France where hundreds of miles separated our base ports from our troops

on the firing-line, there devolved upon the Signal Corps an enormous amount of work in the area known as the Services of Supply. The magnitude of the telegraph and telephone systems in the S. O. S. is illustrated by the fact that when the Armistice was signed, the Signal Corps in France was operating 96,000 miles of circuits known as "long lines," with 282 telephone-exchanges, and a total of nearly 9,000 stations. The requirements for wire in the field were even greater. When our operations were at their height in the summer of 1918, it was estimated that the Signal Corps would require 68,000 miles of "outpost wire" a month for use at the front in connecting telegraph and telephone systems. Outpost wire is, I ought to explain, a development of the war. It is composed of seven fine wires, four of them bronze and three of them of hard carbon steel, stranded together and coated first with rubber, then with cotton yarn, and finally paraffined. This wire is produced in six colors —red, yellow, green, brown, black, and gray—in order that it may readily be identified in the field, the red wire running, for example, to the artillery, the yellow to regimental headquarters, green to brigade headquarters, and so on. The enormous amount of this wire required is explained by the fact that very little of it was saved, it being out of the question to pick it up during the hurry and excitement of an advance, while hundreds of miles of it were destroyed during the heavy bombardments which usually preceded an attack.

Within the memory of many of us the size of com-

bat armies was largely determined by the efficiency and scope of their signal systems, it being essential that the forces in the field should be kept within a size which permitted of communication being maintained between all units by means of runners, riders, or visual signals. Those were the days when messengers, often chosen by lot, crawled through the enemy's lines at night in order to bring reinforcements to beleaguered garrisons; when stories of ambush and massacre or urgent appeals for ammunition and food were brought to headquarters by weary riders clinging to the manes of reeking ponies; or when, in the Indian country, cavalry columns communicated with each other by means of heliograph messages flashed from mountain-top to mountain-top, or signal-fires curling slowly skyward.

But all this changed with the introduction of the telegraph and the telephone, the communications of an army thereafter being limited only by the amount of its wire. A far greater change came, however, with the introduction of the radio or wireless, whose area of operations is limited only by the power of the sending apparatus. Now it should be kept in mind that each of the systems of military signalling which I have already enumerated—telegraphs, telephones, radios, panels, lamps, flags, pigeons, runners, dogs, and the rest—is an adjunct to the others—when one fails, another is employed to get the message through. If the wires of the field telegraph and telephone are cut by a barrage, the radio is employed; if a shell knocks out the radio set, the message is intrusted to a pigeon; should the pigeon fail, a runner attempts to take it

through; and if the runner is killed, the message can be communicated, either by means of rockets or by cloth panels spread upon the ground, to the aviators circling overhead.

Despite the new methods of transmitting messages produced by the war, the telephone remains the backbone of the military signal system. Though the portable telephone instrument used by all front-line troops was manufactured in the United States for commercial purposes prior to the war, the switchboard in most general use by mobile troops was originally developed by the French, being the only telephone equipment used by the American forces which was not of American design. This switchboard, which was built in units so that it could be expanded from four to twelve lines, was the "Central" of the front-line dugout, being so compact that it could be carried as part of the equipment of a soldier and quickly put into operation. For the use of the larger field units there was designed a camp switchboard, with provision for forty wires, which when in transit resembled a commercial traveller's sample-trunk. A third type of switchboard, for use at headquarters in the zone of combat, but where extreme portability was not essential, was designed in units, like a certain popular style of sectional bookcase, and could readily be increased to any size required. An important auxiliary to the field-telephone lines was the buzzerphone, an American device for use where extraordinary secrecy was imperative, it being impossible for the German Listening-In Service to eavesdrop on messages sent by this method.

Photograph by Signal Corps, U. S. A.

COMMUNICATION BY USE OF PANELS.

When other means of communication is found impracticable, the infantry can communicate with aviators by means of panels of cloth cut in various shapes spread upon the ground.

A MEMBER OF THE SIGNAL CORPS SENDING MESSAGES BY MEANS OF A LAMP.

Prior to the war the "lance-pole" was used exclusively by American troops in the field, as it permitted of rapid line construction and served its purpose admirably in open warfare. The conditions prevailing in Europe made the use of this pole impracticable, however, and where poles were used at all they consisted of very short stakes with special cross-arms, miniature copies, in fact, of the commercial equipment commonly used in the United States. The enormous mileage of the trench-lines called for vast quantities of insulators, cross-arms, and other special fittings, in all of which there was great wastage, for though the instruments used on the military lines usually had a certain degree of protection, the lines themselves were constantly exposed to artillery and airplane bombardment.

A factor which greatly complicated the supply of the front-line forces with wire was the necessity for maintaining two-way or twisted-pair lines in order to avoid giving information to the enemy, for the detectors used in the German listening-posts were so highly developed that a telegraph or telephone message sent over a "grounded" or single-conductor line was to all intents and purposes sent direct to Berlin. This necessity for a double-conductor line relegated the old field-wire of open warfare to the scrap-heap, a long series of experiments being required to produce a twisted-pair wire which was light enough to permit of easy portability and rapid laying, strong enough to stand the strain of heavy traffic and shell-shock, and withal so well insulated that "leaks" to the ground

might not reveal to the enemy listeners-in facts intended to be strictly confidential. The enormous demands for all types of wire and cables which came both from the A. E. F. and from our allies necessitated the United States being combed for every foot of available material and the speeding up of production until every wire-mill in America was working twenty-four hours a day. Yet, in spite of labor troubles, housing problems, and the difficulties of obtaining material and transportation, the wire-makers at home filled every requirement of the soldiers overseas.

Of all the varied activities of the Signal Corps, none was more fascinating or mysterious in its operation than the work of the Radio Intelligence Sections, particularly the so-called listening-stations, which, by means of supersensitive receiving and amplifying instruments electrically connected with ground-plates placed as close as possible to the enemy positions, were enabled to overhear the ground-telegraph operations of the Germans and the conversation leaking from defective or non-metallic telephone and telegraph circuits. This remarkable service, some of whose achievements would seem to the layman to verge on the miraculous, combined the discoveries of Ohm, Volta, and Galvani with the methods of LeCoq and Sherlock Holmes. These stations could, of course, operate successfully only under favorable conditions, the chief requisites being that the enemy's trenches should not be too far away and that the intervening terrain should be free of creeks, gullies, or other features which might sidetrack the currents which it was de-

sired to intercept. The listening-stations were usually situated in the second line of trenches, the ground-plates being placed about 300 yards apart. In order to obtain satisfactory results it was necessary that the ground-plates should be placed as close to the enemy as possible, the work of installing them, almost under the noses of the Huns, being one of the most hazardous duties which the signal troops were called upon to perform. The men operating the listening-stations had to remain on duty for a week at a time—a considerably longer tour of duty than was required, under ordinary conditions, of the infantrymen. They were expected to possess a fluent knowledge of German and to be able to both speak and understand it as well as they did English, though this requirement was not always fulfilled toward the end. They were thoroughly coached, moreover, in German military phrases and colloquialisms and had to be proficient in recording ground-telegraphy code, which, though slow, is extremely difficult to master. It will be seen, therefore, that the Listening-In Service demanded of its operators continuous interest and constant vigilance, together with a sufficiently active imagination to enable them to piece together the broken or garbled fragments of messages which their instruments might pick up, and to deduce from these messages what the enemy was doing or what he intended to do. Listening-in was very far from being a one-sided game, however, for the Germans, who were thoroughly conversant with its possibilities and limitations, maintained a service which was nearly, if not fully, equal to our own. The

real superiority of our service lay, not in its equipment, but in the boyish enthusiasm of its personnel, many of whom were university undergraduates when the war began. With them the work never assumed the aspect of a daily task which had to be performed whether they liked it or not: they regarded it rather as a game, interesting, fascinating, exciting. The quickness with which they grasped the technicalities of the service was amazing. I knew of one case where a soldier of a Listening-In Section, wholly without previous experience in the work, overhearing a telephone conversation in the enemy's lines which indicated that the watches in that sector were being synchronized, deduced that a raid on the American trenches was being planned. He promptly acquainted the divisional intelligence officer with his conclusions, and when the Germans launched their attack, expecting to take the *verdamte* Yankees completely by surprise, they were greeted by a burst of rifle and machine-gun fire which almost annihilated them. After the moving warfare began it was, of course, extremely difficult to maintain these listening-stations, but when the advance halted, even for a night, listening-stations were always established if conditions permitted.

A far-fetched but, as it proved, entirely correct deduction was made by the operator of a listening-post whose curiosity was aroused by the sudden change in the nature of the conversation taking place over the enemy's lines, familiarity interspersed with profanity abruptly giving way to studied politeness. From this he reasoned that a new division had moved in

during the night. Prisoners captured the next day verified his deduction. Just before the St. Mihiel offensive one of our operators noted that the telephone conversations between the enemy units opposite his station had almost ceased, presumably because a troop movement was in progress which they did not dare to discuss for fear of being overheard, the truth being that the Germans were quietly withdrawing. Though he had practically no conversation to guide him, this by no means discouraged the American listener, who, by comparing the intensity of the T. P. S. (*telegraphie par sol*) signals he overheard, deduced with amazing accuracy the movements of the retiring troops. In comparison with such feats of deduction, Sherlock Holmes's ability to deduce a stranger's occupation from the condition of his finger-nails or the soles of his boots seems absurdly commonplace, doesn't it?

A youth in search of excitement beyond that usually provided by battle could always find it by joining the Listening-In Service. In March, 1918, the American troops holding a certain sector were suddenly ordered to retire to a second line of resistance, but through an oversight the orders for withdrawal were not passed on to the Signal Corps men who were operating the listening-stations out in front. Serenely unconscious, therefore, of the fact that their comrades had fallen back and that German raiding-parties were prowling all about them in the darkness, they remained at their post throughout the night. It was not until the American infantry reoccupied their original position in the morning that the men in the listening-station

learned that for eight hours they had been the only occupants of the sector.

While crawling over No Man's Land to repair a break in a line connecting his station with a ground-plate, a Signal Corps man discovered a wire leading straight toward the enemy's position. Being of an inquiring turn of mind, he followed it up on hands and knees until he actually penetrated the German trenches, where he made the interesting discovery that the enemy's listening-station had tapped the same ground which we were using. Needless to say, he lost no time in crawling back and changing his ground-plates. This feat was paralleled by a soldier who followed an American raid into the German trenches, and, unobserved during the excitement, succeeded in attaching a wire to one of their ground-plates which was well within their lines, and, therefore, presumably in no danger of being tampered with. By this means he listened-in on the enemy's conversations for several days before his wire was discovered and cut.

Though the work of the Radio-Intercept and Goniometric Direction-Finding stations lacked in some measure the danger connected with that of the ground listening-posts, it nevertheless provided many interesting incidents in the life of the Signal Corps man. The function of radio-intercept stations is, as their name implies, the interception of enemy radio messages. Goniometric stations are used, on the other hand, for locating enemy radio-stations, the work being carried on on much the same principles as flash-ranging, which I have described at some length in another chap-

ter. By placing a goniometer—an instrument for measuring angles—at each end of a base line of known length, it is a comparatively simple matter to ascertain the angle of direction of an enemy radio-station, and, by prolonging the lines of these angles until they intersect, the location of the station can be approximately determined. That done, the information was sent to the artillery, which proceeded to sweep the vicinity in which the radio-station was known to be with a hurricane of shell. So highly was this system of radio detection developed that, after the salient at St. Mihiel had been cleared of Germans, every radio-station which our Goniometric Service had located previous to the attack was verified, the greatest error in location being approximately 500 yards. In many cases some of the German wireless equipment was still in the dug-outs, and much interesting printed matter was picked up. This was the first corroboration of the effectiveness of our Radio Intelligence work.

Just as the naturalists can reconstruct from a few bones a prehistoric monster which they have never seen, so the goniometric experts are able to gain an amazingly accurate idea of the organization of an army by locating its radio-stations, for the lines of radio communication which spread fan-wise from army headquarters form a sort of skeleton, as it were, of the army's organization, the location of the various stations and their distance from headquarters indicating quite accurately the position of the corps, divisions, brigades, regiments, and battalions. This fact was, of course, as well known to the Germans as to our-

selves, and consequently extraordinary precautions were taken to prevent the stations from being located. Such a system of communications is known in military parlance as a "net," that serving an army being called an "army net" and that of a corps a "corps net." Just before the American offensive was launched at St. Mihiel a false corps net was set up considerably to the east of the point selected for the attack, this net being operated in as close imitation as possible of the real thing. Thousands of faked messages were sent in code, precisely as though the movements of an army corps depended upon them, and, to add to the verisimilitude of the proceeding, they were strongly seasoned with the profane and violent English with which American radio operators are accustomed to interlard their conversations. The German goniometric operators promptly located this network of radio-stations, and as the messages which were being transmitted appeared to be perfectly genuine, they naturally concluded that they had discovered the unsuspected presence of an American army corps, whereupon the German High Command took steps to move its reserves to the area which apparently was threatened. There is no means of knowing how effective this ingenious stratagem really proved, but the best answer would seem to be the surprisingly slight resistance which we encountered at St. Mihiel.

The operation of the mobile radio-stations which accompanied the smaller infantry units was always a most hazardous and trying business, requiring not only courage but a very high degree of resourcefulness

and self-possession. In one case that I know of a Signal Corps unit received orders to have a trench radio-station installed at a certain exposed point by a certain time. They followed their instructions to the letter, but when their instruments were set up and they were ready for business, they discovered, to their extreme annoyance, that the infantry which was scheduled to occupy the position had failed to materialize and that they and their radio set were well in advance of our lines. From their position in a shell-hole they called up the regimental commander, reported that they were located according to instructions, and inquired what they were expected to do. Whereupon the infantry lost no time in moving up and occupying the position which, as the signalers mockingly asserted, they had been holding for them.

The exigencies of the Great War wrought many strange and startling transformations. Scientists who had devoted their entire lives to discovering methods for prolonging life turned their genius to finding new and effective ways of taking it; the tractor of the Western wheat-fields became the tank of the battle-fields in Flanders; the machinery and chemicals used for the manufacture of dyestuffs were converted to the manufacture of poisonous gases—and the dove became the army carrier-pigeon, bearing, instead of the olive-branch of peace, messages of battle. Though I find that many Americans seem to be under the impression that pigeons were unreliable and comparatively little used, they were, as a matter of fact, the most trustworthy of all the systems of message trans-

mission employed by the fighting armies. When everything else failed, when the wires of the field telegraph and telephone had been destroyed by the German shell-storms, when the radio installations had been demolished, when the runners had been killed and the aviators driven back by the air-barrages, it was the pigeons which took the messages through. The official accounts of their exploits read like the wildest fiction. Over 500 birds were used by our troops in the St. Mihiel offensive alone. Through the messages brought by pigeons, American Headquarters learned of the whereabout of Major Whittlesey and his "Lost Battalion." How trustworthy were these winged messengers is proved by the carefully kept records of the Allied Armies, which show that of the thousands of messages intrusted to pigeons during the four years of the war, 96 *per cent were delivered.*

The use of pigeons as messengers is as old as recorded history, the Chinese, Egyptians, Greeks, and Romans all having used birds for this purpose. Word of the victory at Waterloo was brought to England by pigeons, and pigeons carried from New York to Washington the news that Napoleon had signed the treaty which added Louisiana to the Union. Among the oldest and most successful pigeon-trainers are the Belgians, many of the best flying strains used by the French, British, and American armies having been developed from Belgian stock. When the Hunnish hordes swept across Belgium, one of their first measures was to confiscate or kill all pigeons. For a Belgian to have in his possession a carrier-pigeon was

for him to risk a court martial and death before a firing-party. Many of the pigeons taken from the Belgians were sent back to Germany for breeding purposes, producing birds which served against their former masters, but when the Americans established their watch on the Rhine, they ordered the immediate release of all pigeons in the area of occupation, thus giving thousands of feathered exiles a chance to fly back to their old homes in Flanders.

The Carrier-Pigeon Service of the American Army is a part of the Signal Corps, being composed of officers and men who are expert pigeon breeders and handlers, and who have the ability to impart their knowledge to others. The pigeon section, which was organized shortly after our entry into the war, consisted of two companies with a personnel of 24 officers and about 650 men. The birds used by the army are known to the fancier as "homers" and are really not carrier-pigeons at all, the latter being a large, ungainly show-bird that cannot fly a city block. But our allies persist in calling homers "carrier-pigeons," and our military authorities have adopted the term. The homer has all the qualities required of a military messenger. He is a strong, well-built, racy-looking bird, possessed of indomitable courage. His most characteristic trait is, of course, his remarkable ability to find his home when released at great distances from it. This power, which has been developed by scientific breeding to an almost uncanny degree, is the asset which makes the bird of enormous value to the army. Though scientists have attempted to explain the homing instinct, they

have arrived at different and frequently contradictory conclusions, it being enough to know that it is an instinct with which all birds are endowed to a greater or less degree, and which has been developed in the homer to a stage where it is limited only by the bird's physical endurance. Nature has equipped the pigeon with numerous air-sacs adjoining the lungs, in which a reserve supply of warm air is carried and supplied to the lungs as needed during flight. Over the eye is a transparent lid, called a "blinder," which protects the eye while in flight, and is at the same time transparent, thus providing a sort of natural goggle. Well-trained homers have frequently flown 1,000 and even 1,500 miles, while pigeon-fanciers think no more of a 500-mile flight than horsemen do of a mile trotted in 2:30. On clear days a homer pigeon will fly distances up to 300 miles at a speed close to a mile a minute, though longer distances are usually covered at a somewhat lower rate of speed, the birds instinctively taking advantage of the favoring air-currents and increasing or decreasing their altitude in order to obtain the benefit of them.

Long before the Great War it was discovered that pigeons would "home" to movable lofts as unerringly as to stationary ones, this being of great importance from the military point of view because it made it possible to move the cotes up to within a few miles of the firing-line. It also made it comparatively easy to supply the advanced posts with fresh pigeons. It was found that a week or ten days was usually sufficient to acquaint the birds with the new location of the loft

and with the surrounding country, moves of twenty-five miles without the loss of any birds being not at all uncommon. Each of these mobile lofts was stocked with seventy-five young birds, six to eight weeks old, of the best pedigreed stock obtainable. Clasped about the leg of each bird was a seamless aluminum band bearing a serial number, the year of birth, and the letters "U. S. A." These bands are put on soon after birth and cannot be removed except by destroying them. As the birds had never been outside a loft, it was a comparatively easy matter to settle them in their new homes. Their early training was devoted to the development of their flying strength and stamina and to the habit of quick "trapping," by which is meant the entrance of the bird into the loft immediately upon reaching it, a pigeon that alights on the ground or roosts on the roof of the loft being considered most imperfectly trained. They soon learn to trap without hesitation, a flock of seventy-five birds entering a loft in from ten to twenty seconds after pitching on the roof. To overcome the habit of loafing, birds are fed in the loft after alighting with their favorite grain. After a month or two of this preliminary training the birds are "tossed," to use the phraseology of the fancier, at increasing distances from the loft, so that by the time they are five or six months old they are flying from fifty to seventy-five miles with speed and certainty. They are then ready for service in the trenches. Not all, however, are assigned to the infantry. Every tank crew carries a complement of pigeons, men from the Pigeon Service are frequently

attached to cavalry units, and birds have been used successfully from balloons and airplanes. The infantryman carries his pigeons in a light wicker hamper strapped to his back, each bird wearing a corselet made of crinoline stiffened with whalebone and with strings running to the sides of the basket, thus preventing it from being tossed about and injured.

As long as the ordinary means of communication are working satisfactorily, birds are not used. But when a barrage is laid down and the telephone-wires are destroyed, resort is had to the pigeons. When an advance-party has pushed far ahead of the main force it, too, relies on this method of liaison. In short, when every other method of liaison has failed or is unavailable, important messages are intrusted to the birds. The messages are written on fine tissue-paper, folded into a small wad, and inserted in the aluminum holder which is attached to the leg of each pigeon. The bird is then released, and in spite of the terrific din and confusion of battle, in spite of the enemy shotgun squads, composed of expert shots, whose duty it is to pick off carrier-pigeons, it wings its way through shell and gas barrages to its loft in the rear of the lines. I might mention in passing that though birds are frequently killed while in their baskets by exploding shells, and others die from long confinement without food or care in the trenches, those that survive become accustomed to the roar of cannon and never suffer from shell-shock. On reaching his loft the bird hurries into it through an opening which permits of entry but not of exit, the dropping back of the little door

ringing a bell which announces the arrival of a message from the front, whereupon eager hands strip the cylinder from the leg of the bird, the message which it contains being relayed to headquarters by telephone or despatch-rider.

The pigeons were not always fortunate enough, however, to pass through the battle area unscathed, many birds having succeeded in reaching their lofts with their messages only to succumb to their wounds. During the offensive in the Argonne an American pigeon reached its loft with the leg to which the message was attached severed and dangling by the ligaments, the missile that severed the leg having also passed through the breast-bone. In spite of these injuries and the great loss of blood the heroic bird flew twenty-five miles with a message of vital importance. I am glad to say that the pigeon recovered and was recommended in due form for the D. S. C. An English bird was struck by a piece of shrapnel while homeward bound with a message. Both of its legs were broken and the aluminum message-holder was embedded in the flesh by the force of the bullet. But its spirit never faltered. It struggled on and on, blood dripping from it in an ever-increasing stream, to fall dead at the feet of the loft attendants. Another bird was released from a seaplane which had fallen and was being shelled by a German destroyer. It rose quickly and circled once to get its bearings. Shots resounded from the deck of the destroyer, the bird stopped short in its flight, and a flurry of falling feathers told their tale, but, after a short fall, it recovered and valiantly struggled

on. Within thirty minutes after its release three British destroyers, white waves curling from their prows and clouds of smoke belching from their funnels, came racing toward the scene, whereupon the German turned and fled and the aviators were saved. With wings and body terribly lacerated the plucky bird had flown thirteen miles to a naval air-station and given the alarm. Here is another incident in which a feathered messenger played a hero's rôle. A detachment of French infantry was ordered to hold a certain strategic position at all costs, thereby affording their main body time to retire to another position. The Germans, realizing that the stubborn little band of Frenchmen was balking them of their prey, launched attack after attack, until, borne down by sheer weight of numbers, the defenders were literally engulfed by the wave of men in gray. Just as all that remained of the detachment were making their last stand, a blood-stained pigeon fell exhausted in a French loft behind the lines. The message which it bore read:

"The Boche are upon us. We are lost, but we have done good work. Have the artillery open on our position."

Little has been said about the work of pigeons in this country. Over a hundred lofts were established at the various camps and cantonments, the thousands of birds which they housed proving of no inconsiderable value in the training of the troops for fighting overseas. Everywhere that they were used the birds showed a dependability which won for them the enthusiastic admiration of all who were familiar with their work. Indomitable courage. a gameness which

ends only with death, and a burning love of home are among the qualities most cherished by Americans, and nothing possesses them to a greater degree than the army carrier-pigeon.

Though the Belgians made extensive use of dogs for hauling machine-guns, and though the French used them to a certain extent for liaison work and the British for locating the wounded, they were not utilized by the American forces overseas. A considerable number of dogs, most of them police-dogs and Airedales, were trained at the various camps and cantonments in this country, however, and had the war continued they would undoubtedly have proved of real service in certain forms of work in France. The attitude of the American soldier toward the subject of dogs is best expressed by a story which I heard in France. An American officer, lost at night in No Man's Land, sought refuge in a shell-hole. He found, however, that it already had an occupant, an American doughboy—from his accent evidently a product of the Bowery—who, it appeared, was lost like himself. In the periodic bursts of light afforded by the star-shells the officer noticed that the man had strapped to his back what appeared to be a large basket.

"What have you in there?" he inquired curiously.

"Boids, cap'n, boids," the soldier answered in a hoarse whisper, adding disgustedly: "An' that ain't the woist of it, cap'n. I hear they's goin' to give us dawgs!"

Though Americans have always been the greatest photographers in the world, the Yankee abroad being

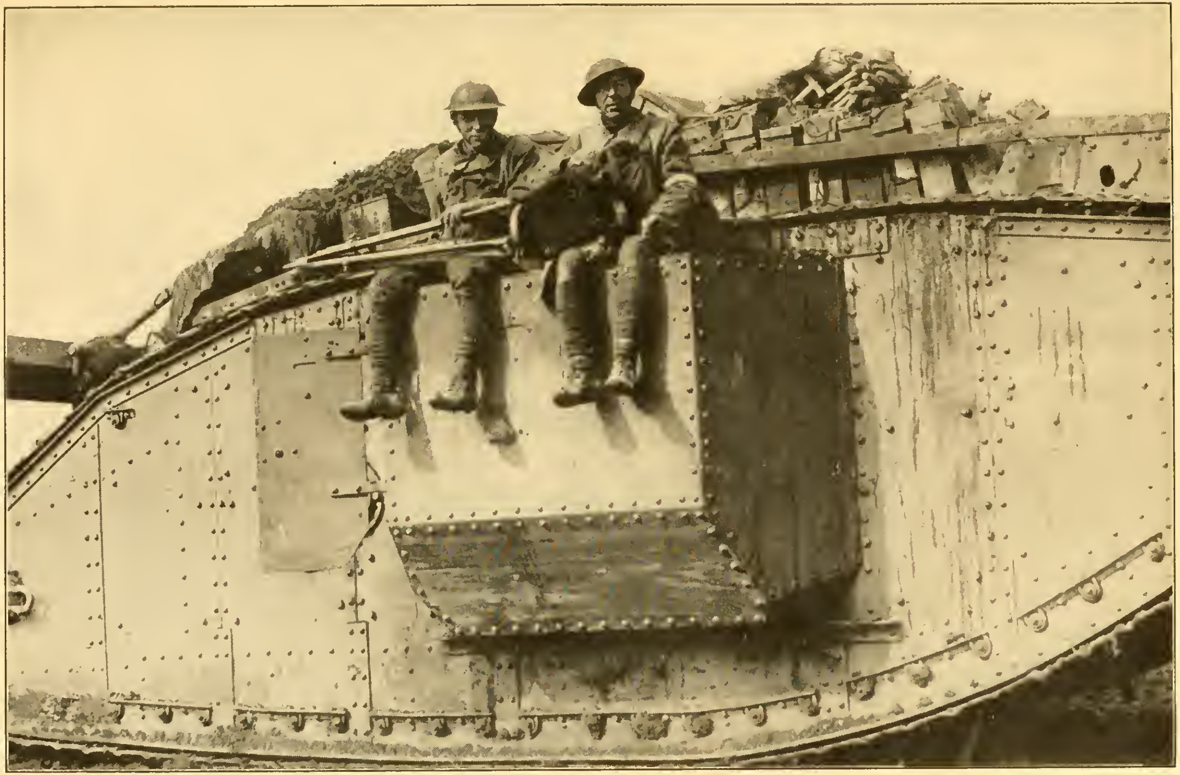
readily distinguishable by his ever-ready kodak, it is a rather surprising fact that it needed the World War to convince the American military authorities of the vital importance to the army of the camera. Upon our entry into the war, however, the War Department, following the example of the European armies, established a photographic section, with a personnel of forty-odd officers and nearly 800 men, as a part of the Signal Corps. The duty of this section was to take pictures, both still and motion, of every phase of America's participation in the war, both on the fighting front in Europe and in the training-camps at home; for the information of the intelligence officers of the A. E. F., for the guidance of the artillery, for purposes of instruction in the schools and cantonments, for propaganda use at home and in foreign countries, and for illustrating the official history of the great conflict.

The photographic section was divided into two branches, land and air, the latter being, perhaps, from a military standpoint, the more important of the two for the reason that airplanes were used primarily for reconnaissance work and were, when equipped with cameras, literally the eyes of the army. The airplane being the eye of the army, the camera may be said to have been the pupil of the eye. In order to provide the large and highly trained personnel required for this service, there was established at Rochester, New York, a School of Aerial Photography—the largest in the world—where candidates received, in addition to a thorough military training, a course of instruction in everything relating to modern photography, from the

manufacture of plates and films through the selection and use of lenses, shutters, and light-filters, to the printing of the picture itself. In addition to becoming familiar with these details of commercial photography, they were instructed in all the special phases of military photography, such as map-plotting, mosaics, enlargements, and the study of topography from a negative made many thousands of feet in the air. As in that chapter dealing with the Air Service I have described in considerable detail the methods and instruments used in aerial photography, it is enough to say here that the aerial branch of our Photographic Service attained such a degree of efficiency that, in the closing months of the war, it became virtually impossible for the Germans to dig a dozen yards of new trench, to transfer a platoon, to change the position of a machine-gun, without being detected by the all-seeing eyes of our cameras.

The mother school for land photography was located at Columbia University, in New York, where the students received the same thorough training which was given to the aerial operators at Rochester, with instruction in motion-picture photography added. The students at this school were the pick of the newspaper photographers and motion-picture operators of America. Among them were men who had "snapped" presidents and potentates, celebrities and notorieties, prize-fighters, reformers, murderers, prelates, politicians and statesmen, leaders of society, Society and near-society; who had "filmed" presidential inaugurations, Newport weddings, railway disasters, yacht-

races, South Sea cannibals, Mexican revolutions, and Heaven knows what besides. Their courage and resourcefulness were precisely the qualities which were required of army photographers, for there was nowhere that they would not go, nothing that they would not do, and the more danger there was in their work the more it appealed to them. When a new type of gun was being fired for the first time and the gun crew took refuge in the bomb-proofs as a precaution against accident, the army movie-men moved their machines up close in the hope that if the gun exploded they would get a picture of the explosion. One of the Signal Corps operators, Captain Edward N. Cooper, with his assistant, Sergeant Adrian Duff, while attached to the Twenty-Sixth Division, crawled out into No Man's Land just before an attack was scheduled to take place, and, though exposed to both German and American fire, set up their machine in order that the people at home, seated comfortably in motion-picture theatres, might actually see the boys going "over the top." On another occasion this same young officer became separated from the troops to which he was attached and found himself under the fire of a German machine-gun, but in spite of the hail of bullets he stuck to his work, made his pictures, and returned to the American lines herding in front of him a group of Germans whom he had captured single-handed at the point of an empty revolver. A camera-man whom the French Government detailed to accompany me along the Western Front in 1916 was seriously wounded by a German shell just as we were leaving Verdun. His



Photograph by Signal Corps, U. S. A.

MOTION-PICTURE OPERATORS OF THE PHOTOGRAPHIC SECTION OF THE SIGNAL CORPS GOING INTO ACTION ON A TANK.

There was nowhere they would not go, nothing that they would not do, and the more danger there was in their work the more it appealed to them.

Photograph by Signal Corps, U. S. A.

AN OFFICER OF THE SIGNAL CORPS OPERATING A TELEPHONE AT THE FRONT.

This instrument was so compact that it could be carried as part of the equipment of a soldier and quickly put into operation.

assistant helped me to give first aid to his chief and then, though the road was being heavily bombarded, coolly set up his machine and turned the crank while the wounded man was being lifted into an ambulance. It is a striking commentary on the scepticism of American audiences that, when I showed that picture in the United States, fully half of the people who saw it insisted that it had been faked. Another officer of the photographic section who, before our entry into the war, as the representative of a Chicago newspaper had accompanied the German Armies during the invasion of Poland, was present at the capture of Warsaw. When the Kaiser reviewed the troops after his triumphal entry into the captured city, the American pushed his way through the cordon of soldiers and police agents which surrounded the imperial motor-car, set up his machine within six feet of the astonished Emperor, and proceeded to take a "close-up" of the All Highest, who was so amused by the effrontery of the performance that he insisted on shaking the photographer's hand!

Motion-pictures were used in the training of troops far more generally than the public realized. A series of pictures taken at the Military Academy at West Point and exhibited at every camp and cantonment in the United States did more in a few hours to acquaint the troops with military etiquette and the evolutions of the squad, the platoon, and the company than any number of drills and lectures could have done. "Animated drawings," as they are called —like those of Mutt and Jeff and the Katzenjammer

Kids—were made under the direction of the Signal Corps for the purpose of familiarizing the men with the mechanism of the service rifle, the automatic pistol, and the various types of machine-guns. By running these pictures slowly, every stage of the operation of loading and firing was made clear, from the insertion of the cartridge into the clip or belt to the bullet leaving the muzzle. But the greatest value of the motion-picture, when all is said and done, was in keeping up the morale of the American people by combating the insidious and undeniably clever propaganda which was carried on in this country by the Germans. Enemy agents spread reports that the drafted troops were being ill-treated in the camps, that they lived in wretched quarters, were poorly fed, and suffered from lack of proper clothing. To answer these charges a score of movie-men were despatched to the various camps, the pictures which they took and which were exhibited throughout the country showing the clean and comfortable barracks, the men seated at their bountiful and appetizing meals in the mess-halls, the football and baseball games, the camp theatres, and the other features of cantonment life, thus providing a convincing refutation of the German insinuations. Parents who had heard the widely circulated tales of the unsanitary and immoral conditions to which their boys were exposed in France could go to their local motion-picture houses and see for themselves the clean dormitories, the Y. M. C. A. and Knights of Columbus huts, the social gatherings, the splendidly equipped hospitals, incidents of life in the back areas and in

the trenches, and not infrequently the faces of their loved ones themselves, sun-bronzed and happy, wearing "the smile that won't come off." If the photographic section of the army had accomplished nothing else, its existence would have been justified a thousand times over by the service which it performed in fighting the propaganda of the Hun and in bringing cheer and comfort to the parents, wives, and sweethearts whom the boys had left behind them.

As a result of the researches and experiments which it carried on during the war, the Signal Corps has, in addition to its countless other achievements, produced several devices which are of such an astounding nature as to strain almost to the breaking-point the credulity of the layman. I am not permitting myself to indulge in the slightest exaggeration when I assert that these devices place in the hands of the United States weapons which would render this country wellnigh invulnerable in the event of our ever becoming involved in another war. But—and herein lies their greatest significance and interest—they are, beyond all question, the most important inventions, so far as their effect on the peaceful interests of the nation are concerned, which have been produced since Morse invented the telegraph, Bell perfected the telephone, and Marconi amazed us with the wireless. Imagine the value of a device which permits of a conversation being carried on between a person on the ground and an aviator in the clouds as easily as though they were seated opposite each other at a dinner-table!

Such is the radiotelephone, which I have described in detail in the chapter on the Air Service but which was suggested and brought to a state of perfection by officers of the Signal Corps. Conceive, if you can, of another device which permits of nineteen separate and distinct telephone and telegraph messages being transmitted simultaneously over a single copper wire! Picture the advance in world-communication made possible by the discovery, made by General Squier, the Chief Signal Officer of the Army, that growing trees can be used as natural antennæ for both sending and receiving radio messages! And, as a climax to this amazing list of achievements, let your imagination attempt to grasp the military and commercial significance of a device for the sending over telegraph wires or cables of cipher messages which, though they can defy any system of deciphering known to science, appear in plain language at the other end! You may think, perhaps, that I am overenthusiastic; that I have used too many adjectives and exclamation-marks. But suppose that I tell you something about these inventions. Then, unless I am greatly mistaken, you will be guilty of adjectives and exclamations yourself.

Owing to the difficulty of constructing in France enough telegraph and telephone lines to meet the constantly increasing requirements of the American Expeditionary Forces, as well as to relieve the great congestion which prevailed on all of the existing lines, the scientists of the Signal Corps turned their attention early in the war to the possibility of sending several messages simultaneously over a single wire.

Without entering into the details of the long series of experiments which were conducted by the Signal Corps, in conjunction with the American Telephone and Telegraph Company at Camp Alfred Vail, New Jersey, or attempting to describe in terms which would be intelligible to the non-technical reader the device which was finally perfected, it may be said that the result is accomplished through the application of radio, the wire serving as a guide for the radio currents and conducting them with a minimum of power and with a minimum of interference with other radio communications. This device has now been brought to such a state of perfection that eight telegraph messages and eleven telephone messages can be carried over a single wire at the same time, the Morse messages being transmitted by means of the multiplex telegraph apparatus—a system which was discovered as early as 1910 and is now in general use by the large telegraph companies—while the telephone conversations are guided by wireless waves, which serve as carriers for the voice currents. By placing on ordinary telegraph-wires wireless waves of very short length or of very great frequency, officers of the Signal Corps have successfully conversed over a line from Washington to Baltimore which was being used at the same time for the transmission of duplex telegraph messages. Perhaps the most remarkable feature of the performance was its extreme simplicity, the feat being accomplished merely by placing on the line, through proper connecting condensers, a pair of radiotelephone sets such as are used for communicating between ground-stations

and airplanes. Whereas it was believed, until very recently, that it was impracticable to hold more than four wired-wireless conversations over one wire or one pair of wires, in addition to whatever ordinary telephone or telegraph conversation might be on that wire, the Signal Corps has now demonstrated that it is not only possible but entirely practicable to hold ten or more extra telephone conversations without their interfering with each other. Had this system been perfected while the war was in progress it would have meant that ten telephone and two or more telegraph conversations could have been carried on simultaneously with a point served only by a single wire. In other words, by the application of this system one wire will take the place of ten.

Another phase of science uncovered by the Signal Corps which figuratively makes the mind of the layman stand still and gasp is the discovery, due to the experiments of the Chief Signal Officer, General Squier, that trees can be used as instruments in the receipt and transmission of electrical messages, both telegraph and telephone, both by wire and wireless. Think of it, my friends! The commonplace tree possesses those very qualities that men have spent centuries of effort to embody in a frail spider's web of wire!

"From the moment an acorn is planted in fertile soil," to quote the words of General Squier himself, "it becomes a 'detector' and a 'receiver' of electromagnetic waves, and the marvellous properties of this receiver, through agencies at present entirely unknown to us, are such as to vitalize the acorn and to produce

in time the giant oak. In the power of multiplying plant-cells it may, indeed, be called an incomparable 'amplifier.' From this angle of view we may consider that trees have been pieces of electrical apparatus from their beginning, and with their manifold chains of living cells are absorbers, conductors, and radiators of the long electromagnetic waves as used in the radio art. For our present purpose we may consider, therefore, a growing tree as a highly organized piece of living earth, to be used in the same manner as we now use the earth as a universal conductor for telephony and telegraphy and other electrical purposes."

Not only have telephone conversations, in which the voice is transmitted just as clearly as by the ordinary metallic circuit telephone, been carried on from tree to tree, up to a distance of three miles, in the outskirts of Washington, but while the war was still in progress the signal officers, using tree-tops as antennæ, read messages from ships at sea, from aviators in the sky, and from the great radio-stations in South America and Europe. As a result of this discovery, the lofty and costly towers which are now used for the sending and receipt of radio messages will no longer be a necessity. All that will be necessary is to drive a spike in a tree, attach a wire to the spike, and run the wire to a radio apparatus, whereupon messages can be received and sent, the distance covered depending upon the power of the instrument. The tree telegraph has been dubbed by General Squier a "floragraph" and the tree telephone a "floraphone," while the messages transmitted over this arboreal system are to be known as

"floragrams." Though this discovery will in all likelihood result in an amazing expansion of the world's system of communication, and though it will give radio-towers, thousands of them, in fact, to every village and to every farm, it does not necessarily mean that every man who possesses a vine and fig-tree will be able to sit on his front porch and gossip with his neighbors.

During the war the offices of the Chief Signal Officer were literally besieged by persons who claimed to have invented various systems of message transmission which could not be tapped, or which, if they were tapped, could not be understood. It was perfectly well known to us, of course, that the German Listening-In Service, particularly in the front-line trenches, was well organized and extremely efficient, and that telephone and buzzer conversations held over our wires were frequently intercepted. It was known, moreover, that Germany had spies, both in France and the United States, whose sole duty it was to tap the governmental telephone and telegraph systems for the purpose of obtaining military information. Scores of devices designed to secure the inviolability of the vitally important messages which were constantly passing over the wires were submitted to the Signal Corps. Anxious as they were to obtain a system of message transmission which could jeer at the efforts of the enemy's spies, the experts of the Signal Corps steadily maintained that such a thing did not exist, for, as they said with truth, if an instrument could be devised which could transmit and decode a message,

there was no reason why the Germans could not in time manufacture one like it, put it on the line, and thus obtain the information desired.

One of the inventors who approached the Signal Corps asserted that, though he did not claim to have a device which would render a message indecipherable, he had a system which made it impossible for an enemy agent to tap the wire over which messages were being transmitted without the sender and receiver being instantly notified that some one was eavesdropping upon them, whereupon their conversation would, of course, cease. "Prove it to us," said the Signal Corps, and provided the inventor with an opportunity to demonstrate his system over a miniature line. Without the slightest difficulty the military experts tapped the line and, with the aid of a stenographer, recorded every message which was sent over it, the quantity of energy which they withdrew for the purpose being so minute that the delicate detectors failed to record the fact that the line had been tampered with.

Another system had as its basic principle the breaking up of the groups of Morse dots and dashes which represented the letters of the message, and routing these mangled fragments over widely separated wires to the receiving-station, where they were automatically joined together again so as to form the message as originally sent. If, for example, it was desired to send from Hoboken to Washington the message "*Transport Leviathan sails June twenty-fifth*," it was proposed to make use of two lines, one running, let us say, through Harrisburg, the other via Wilmington. The message

sent over the Harrisburg wire would be broken up something after this fashion: "t-a-s-o-t-e-i-t-a-s-i-s-u-e-w-n-y-i-t," while the portion going by way of Wilmington would read: "r-n-p-r-l-v-a-h-n-a-l-j-n-t-e-t-f-f-h." To create still further confusion in the mind of any one who might succeed in intercepting one of these sets of fragments, it was proposed to superimpose a "camouflage" message upon the disconnected letters, the characters of the camouflage message to occupy the spaces between the characters of the real message. By an exceedingly ingenious device, these apparently inextricably intermixed and unrelated letters were automatically sorted out at the receiving-station and pieced together, like a jigsaw puzzle, so that the message appeared precisely as it was sent. Going a step further, the inventors of this system proposed by the same means to install a system of telephone communication whereby the spoken words would be broken up just as the Morse characters were divided, certain sounds in each word going over one wire and the remaining sounds over another, to be joined together at the receiving-station into a perfectly intelligible conversation. Here again a wholly separate and extraneous conversation was superimposed over the sounds proceeding by each route, so that were either of the lines tapped the listener-in would be rewarded for his pains by hearing a torrent of sound which would convince him that he was listening to a combination of Choctaw, Chinese, the ravings of John McCullough, and the symptoms of a severe cold. Notwithstanding the undeniable ingenuity of this system, the Signal

Corps experts demonstrated, to the unconcealed astonishment of the inventors, that they could overhear and understand these crazy-quilt conversations as readily as though they were being held across a dinner-table in plain English.

Early in 1918, however, the American Telephone and Telegraph Company, becoming interested in the solution of this apparently insoluble problem, produced a device whereby a message could be transmitted over a wire in such a form that it was absolutely indecipherable to any one save the person for whom it was intended. As originally developed, this system was unable to do all that was claimed for it, but, thanks to the co-operation of the Signal Corps, there was finally produced an electrical device which will transform an ordinary message into cipher, transmit it with absolute secrecy, and decode it at the other end—all at the rate of from forty to seventy words a minute. This may be said to be the only cipher in existence which is absolutely indecipherable and at the same time practicable. As universal peace is not yet within sight, even with the aid of a telescope, and as this invention would prove of incalculable value to the United States in the event of our again becoming involved in war, it is obviously out of the question to discuss the principle on which it is based, much less the details of its construction and operation. It is enough to say that this nation is now the possessor of a system of code transmission which can defy all the experts in the world, a message sent by its means being absolutely indecipherable to the inventor himself.

Though before the signing of the Armistice this device was operating between several points in the United States with complete satisfaction, the apparatus could not be manufactured in time to permit of its use overseas before the end of the war. The engineers of the Signal Corps assert that this device will eventually be perfected to a degree of commercial practicability which will make it possible to transmit cipher messages over cables as well as land lines without the necessity of manual transmission and without the use of a recorder. As the machine codes and decodes messages automatically, the large code-room forces which were used in Washington during the war, and which are employed by many of the great banking and commercial institutions, would no longer be required, thus doing away entirely with the labor at present involved in coding and decoding messages and cutting down the time required for their transmission by many hours.

II

"ESSAYONS"

IF, the next time you meet an officer of Engineers, you will observe his uniform closely, you will perceive that the buttons of his tunic, instead of being embossed with the arms of the United States, like all other branches of the service, bear a device consisting of an eagle, a castle, a rising sun, and the motto "*Essayons*." Like the bow of black velvet, called a "flash," which the Royal Welsh Fusiliers have sewn at the back of their collars to commemorate the fact that they were the last regiment in the British Army to wear the pigtail, so the buttons of the Engineers serve to remind their wearers that the famous organization is as old as the nation, tracing its history back to the Corps of Artillerists and Engineers of the Continental Army.

"*Essayons*"—"Let us try." One likes the quiet confidence of the motto.

"Can you make roads for my guns through the swamps of the Wilderness?" asked Grant.

"Let us try," replied the Engineers—and the roads were built.

"Can you build docks for disembarking ten thousand men a day and railways to carry those men to the front?" asked Pershing.

"Let us try," the Engineers responded—and al-

most overnight miles of docks and networks of rails appeared as though at the wave of a magician's wand.

"Can you locate the enemy's guns by their sound? Can you keep our troops supplied with water? Can you print maps? Can you make dugouts? Can you operate search-lights? Can you dredge harbors for the entrance of our transports? Can you build highways and keep them in repair? Can you quarry the stone for those highways? Can you cut a million feet of lumber a day? Can you design better types of armored cars, sound-detectors, mobile cranes, portable sawmills, listening apparatus, mapping cameras, steel bridges, barbed-wire entanglements, than any in existence? And, if the necessity arises, can you fight?"

"*Essayons*," answered the Engineers—whereupon all these things were done.

Whenever the army has had work to be done which no one else knew how to do, they have sent for the Engineers. Who designed, built, and operated our tanks before the organization of the Tank Corps? The Engineers. Who organized the Gas and Flame Regiment? The Engineers. The Camouflage Corps? The Engineers, of course. Who did the mining, quarrying, timber-cutting, well-driving, dock, bridge, road, railway, and camp building for our armies overseas? Again, the Engineers. Indeed, I doubt if any organization of any army in the Great War can show such a record of varied activities and successful accomplishments as the Corps of Engineers. One can say of the American Engineer, as Kipling said of the British Marine:

"There isn't a job on the top o' the earth the beggar don't know
nor do—
You can leave 'im at night on a bald man's 'ead to paddle 'is
own canoe;

. . . .

They think for 'emselves, an' they steal for 'emselves, an' they
never ask what's to do,
But they're camped an' fed, an' they're up an' fed, before our
bugle's blew."

The immense importance attached to the work of the Engineers is strikingly illustrated by the fact that, whereas the army was increased to 19½ times its pre-war size, the enormous problems of field fortification, construction, and transportation, both with and behind the fighting forces, as well as the direction of many entirely new phases of warfare, necessitated an increase of the Corps of Engineers to 131½ times its strength at the beginning of the war. Prior to July, 1916, the corps consisted of only three battalions, with a total strength of not over 1,900 men, but when the Armistice was signed there had been organized, or were in process of organization, 500 Engineer units, with a strength of some 312,000 men, or more than 10 per cent of the entire army.

Now it must be kept in mind that in the original corps of pre-war days the men were trained only as sappers and not in the countless specialist branches which were developed by the great conflict. The fundamental use of sapper troops is, theoretically, at least, the supervision of technical work during tactical operations. One regiment of sappers is normally assigned to each division, is under the immediate command of

the divisional commander, and operates as directed by him. To this regiment is given the work of organizing positions for defense, which includes the construction of trenches, gun-positions, ammunition-dumps, and dugouts, the repair and maintenance of roads in the divisional area, the construction of shelters where required, and the general direction of the work necessary to keep open the lines of communication and supply. In open warfare it is customary for the divisional commander to hold his sapper regiment in reserve to be used for applying the decisive pressure or resistance at the moment when it is most needed. When going forward with the infantry, sapper troops usually have a definite technical mission, such as the organization of captured ground, the destruction of obstacles and the bridging of streams. During a retreat they are attached to the rear-guard, being charged with the demolition of bridges, the obstruction of roads, and the cutting of railway communications. Though the ranks of the Engineers were filled, for the most part, with men who were experts and specialists in certain trades and professions, they were time after time thrown into the line as combat troops, fighting shoulder to shoulder with the infantry. On more than one occasion they showed that, destitute of combat training though many of them were, they could handle a rifle or a machine-gun as well as an axe or a spade. At Cambrai the 11th (railway) Engineers, caught in the German counter-push, offered a stubborn and heroic resistance against overwhelming numbers. At Amiens another railway regiment, the 11th Engineers,

formed a part of the little force with which General Sandeman Carey blocked the gap in the British line and thereby prevented the Germans from breaking through to the Channel ports. For its behavior on that occasion the regiment was cited by the British and its commander was decorated. Perhaps you were not aware that two companies of Engineers fought alongside the Marines in the Bois de Belleau. And, when the gray hordes of Hindenburg were reeling back from the Marne, a report from the Rainbow Division ended: "Our advance troops, the 117th Engineers, are pressing the enemy closely." But the story that will live longest in the annals of the famous corps is that of the sergeant of the railway regiment at Cambrai, who, surrounded by the enemy, refused to surrender and defended himself with his only weapon, a crowbar. When they found him, hours later, the crowbar was still clutched in his dead hand. About him, with crushed skulls, lay seven Germans.

The innumerable new devices produced by the Great War, however, required for their operation great numbers of specially trained men, so that the Corps of Engineers, from an organization consisting solely of sapper troops, found itself called upon to do more and more work in almost every branch of engineering. To meet these demands men were accordingly trained as specialists and assigned to specialist regiments and battalions, so that, when the war ended, the Corps of Engineers consisted of camouflage, car-repair, crane-operator, dock-construction, dredging, electrical and mechanical, forestry, general-construction, highway,

inland-waterway, light-railway construction, shop, and operation, locomotive-repair, military-mapping, mining, pontoon park and train, quarry, railway-transportation, road, sapper, search-light (including anti-aircraft), sound-and-flash-ranging, standard-gauge railway-construction, operation, shop and maintenance-of-way, supply, surveying and printing, trades and storekeepers, transportation and water-supply troops, organized as needed into companies, battalions, or regiments.

Now it was realized, from the very beginning, that the success of our armies in France would depend upon transportation. And, thanks to the threats of Pancho Villa, we had at least the framework of a transportation organization, for when it became necessary to send troops to the Mexican border in 1916, the War Department had organized a transportation service of sorts and had placed Samuel M. Felton, president of the Chicago Great Western Railway, at the head of it. Thus it came about that upon our entrance into the Great War there devolved upon Mr. Felton and his staff the gigantic task of obtaining in the United States and shipping to Europe the enormous quantity of transportation equipment and supplies required for the use of our forces overseas. In order to ascertain just what was required in equipment and supplies, a commission, headed by Colonel William Barclay Parsons, president of the American Society of Civil Engineers, and Colonel (then Major) W. J. Wilgus, formerly vice-president of the New York Central system, was sent to Europe within less than thirty days after

the declaration of war. Upon the completion of its preliminary survey of the situation the commission dispersed, leaving Colonel Wilgus as the sole nucleus of the American Transportation Service in France, with Captain L. A. Jenney, formerly chief draftsman of the New York Central, as his assistant. Sitting on soap-boxes in an office in the Boulevard Haussman in Paris, with packing-cases for desks, these two officers outlined the general policy with respect to military transportation for the A. E. F. which the conditions seemed to warrant, and which General Pershing later adopted, and drew up the first requisition for railway and port equipment, materials, and tools. Colonel Wilgus, himself a veteran railroad man, quickly realized the vastness of the problem which confronted us and the gravity of the situation resulting from the dilapidated condition of the French railways and the appalling shortage of French rolling-stock. He accordingly informed the War Department that the American Army must prepare to operate its own trains, made up of its own locomotives and cars, from the seaports to the front, over the French railways under trackage rights. I might add that the principle of trackage rights, so familiar in America, was entirely unknown in France, and at first the French railway officials did not know what Colonel Wilgus was talking about, for they found it difficult to understand how it was possible to operate two systems of transportation over the same tracks at the same time.

The story of how the Engineers, under the direction of Brigadier-General W. W. Atterbury, formerly

vice-president of the Pennsylvania, Director-General of Transportation, with Colonel Wilgus as his deputy and Chief of Staff, built up in France a transportation system which was one of the marvels of the war, is outside the province of this narrative, while the story of the production of railway material in America and its shipment overseas would require, for its proper telling, a chapter to itself. It is enough to say that, when the Armistice was signed, 60,000 men were engaged on railroad work of various kinds in France; more than a thousand miles of standard-gauge railway (equal to the distance by the Pennsylvania from New York to Chicago) had been laid; upward of 1,300 locomotives (300 more than are owned by the Atchison system) had been shipped overseas, and, had the war continued, we would have had in France by July, 1919, enough American cars to make up a train the caboose of which would have been leaving Paris when the engine was entering Berlin.

The Transportation Department had in operation between Tours, which was the headquarters of the Services of Supply, and Chaumont, which was the Great Headquarters, an all-American train, drawn by an American locomotive, driven by an American engineer, and, as a final touch, with its sleeping-cars in charge of former Pullman porters, in khaki, it is true, but retaining their grins and their whisk-brushes. Every one in the A. E. F. was inordinately proud of that train, which stood as a sort of visible proof of American accomplishment in France. It had been officially christened the "Atterbury Special" in honor

of the Director-General of Transportation, but the soldiers had disrespectfully dubbed it the "Attaboy Special." One morning, as a group of American congressmen, on their way up to the front, were standing on the platform of the Tours station, the special came roaring in.

"There's an example of American energy and promptness for you!" exclaimed one of the politicians proudly. "What a contrast to those wretched French trains! Not an hour or so late, as they are, but on time to the very minute."

"Pardon me, sir," said a military policeman who had overheard the conversation, "that is *yesterday's* train."

When it was first proposed by the Transportation Department that locomotives should be shipped to Europe without being knocked down, the Ship-Building Board vigorously protested. There were no ships in existence, the board said, which could stand up under such an immense concentrated load. But the Engineers proved that they knew more about the strength of ships than did the ship-builders, and the locomotives —533 in all—were run out onto the wharves on their own wheels, picked up as easily as though they were baby-carriages by the giant gantry cranes, deposited in the hold—35 to a ship—together with their tenders, packed in baled hay, and upon arrival at the French ports were lifted out by the same method, lowered gently onto the rails, and a few hours later rolled off for the front under their own steam. The success with

which the Engineers utilized business methods and revised specifications to meet American manufacturing conditions is strikingly illustrated by the fact that the cost of these locomotives, for which the French had been paying $51,000 each, was brought down to $37,000, thus saving to the American taxpayer some seven millions of dollars—a very tidy sum.

And, apropos of rolling-stock, here is a bit of secret history hitherto unpublished. When Villa's raiders were threatening to destroy the railway-lines paralleling the Mexican border, the Engineer Corps designed and built a number of self-propelling armored railway-cars armed with 3-inch rifles, machine-guns, and search-lights. When the German submarines began their piratical operations along the Atlantic seaboard in the spring of 1918, these moving fortresses were secretly rushed up from the Rio Grande in order to afford protection to the undefended Jersey coast towns. It was well for the U-boat commanders that they did not attempt to shell Long Branch and Atlantic City as they shelled Scarborough and Broadstairs. If they had, the Engineers and their armored cars would have given them the surprise of their lives.

The non-military person does not ordinarily associate with war such prosaic occupations as lumbering, quarrying, and highway building. They seem, at least at first thought, to be in character essentially industrial. But it must be remembered that the workman played fully as great a part as the soldier in winning the Great War. In fact, the combat troops could not

have held the line for a day had it not been for the labor battalions, which, without incentive or excitement, glory or reward, and in most cases without public appreciation, toiled so faithfully and unceasingly to build the wharves, to unload the ships, to lay the railways, to construct the roads, and to hurry forward, in an unending stream, the food for the men and the food for the guns. It is quite understandable, once you stop to think about it, that in order to maintain our great armies in the field, there were required immense quantities of lumber for building wharves, barracks, storehouses, hangars, and hospitals, and enormous amounts of stone, crushed rock, and gravel for metalling the roads, ballasting the railways, buttressing the bridges, and making concrete for the fortifications. When we entered the war the supply of lumber was not nearly equal to the demands of the Allied Armies, to say nothing of our own. And, though there was, of course, plenty of rock and gravel in this country, we could not spare the tonnage to ship it overseas, even had such a course been practicable. (Perhaps it has never occurred to you how vitally important an item gravel is in military operations. Yet at one time the Germans threatened the Dutch with war if the latter persisted in their refusal to permit German gravel to be shipped across Holland for the construction of concrete fortifications in Belgium.) In view of these conditions, it devolved upon the Engineers to organize and equip special forestry, quarry, and highway regiments, as well as numerous labor battalions, and hurry them overseas with orders to obtain

the urgently needed materials from the forests and quarries of France.

Though Engineer officers of the regular establishment were, of course, given command of these specialist regiments, the other officers as well as the soldiers themselves were recruited from men trained in the particular sort of work which each regiment was expected to perform. How to obtain officers of sufficient experience in these various lines of industry, and in sufficient numbers, promised at first to be a serious problem, but it was quickly solved by the Personnel Division of the Engineers, which had had on file, ever since the war-clouds first appeared on America's horizon, tens of thousands of letters from men trained in every branch of the engineering profession, offering their services to the government in case of war. Hence, when it was decided to raise a forestry regiment, it was a simple matter to turn to the files and find the names of thousands of men—mill-owners, forest-rangers, lumbermen—with their experience and qualifications carefully listed, who were intimately familiar with every phase of the industry, from tree to finished board. The best qualified of these applicants were offered commissions by telegraph and instructed to go out into the lumber country and recruit their companies and battalions from men who had worked under them or whom they knew. Soon the walls of every employment-office, bunk-house, and cook-shack from the pine woods of Maine to the spruce forests of Washington blossomed with posters calling for axemen, sawyers, log-drivers, timber-cruisers, mill-opera-

tors, cookees, teamsters, for immediate service overseas. The response was prompt and startling. From their camps on the Kennebec and the Androscoggin, from the Adirondacks, from the pine-clad shores of Superior and Huron, from the Michigan Peninsula and the North Woods of Minnesota, from the forested slopes of the Wind River, the Bitter Roots, and the Cascades, from the big timber of the Far Nor'west the lumbermen came pouring in, in mackinaws and parkas, in moccasins and shoepacks, in knitted toques and caps of fur, their scanty belongings wrapped in the blanket-rolls slung across their backs and often with their axes on their shoulders. Sinewy-limbed, saddle-colored, horny-handed, tough as the timber of the forests whence they came, these were the real pioneers, the conquerors of the wilderness, the last of the frontiersmen, and Europe will, in all likelihood, never see their picturesque like again.

The first of the forestry regiments, the 10th Engineers, sailed for Europe five months after the declaration of war, followed at short intervals by several similar organizations. Immediately upon their arrival in France lumbering operations were begun in the Vosges and the Pyrenees (so do not be surprised if the next time you go shooting in Maine or fishing in Michigan your guide interlards his conversation with French or Spanish phrases), using French mills at first but later installing plants of the American type. The enlisted men of the forestry outfits were, as I have said, for the most part lumbermen by trade, officered by men familiar with lumbering in all its details. The result

was a striking illustration of what American energy and American methods can do, for the official reports show that mills which, under French management, were yielding 500 board feet a day, were made to yield ten times that quantity when operated by Yankee lumbermen. In the Vosges this work was carried on so close to the front that the plants were repeatedly bombed by enemy aircraft and shelled by enemy artillery, the forestry troops, though listed as non-combatants, frequently suffering heavy casualties. It took a high order of courage for these men to go unconcernedly about their business of tree-felling, hauling, and sawing with German shells yowling through the branches and bursting all about them. The sawmills were of the portable type, however, and when the fire of the German guns became too accurate and heavy, the whole plant was packed up and shifted to a new location. I don't believe in letting loose upon my defenseless readers swarms of figures, but it will serve to give those of them who are familiar with lumbering some idea of what our forestry regiments accomplished when I mention that during the month of October, 1918, alone, they produced 50,000,000 board feet of sawed lumber, 80,000 cords of firewood, and enough standard-gauge ties to build a single-track railway from the Great Lakes to the Gulf.

In raising the quarry, highway, and inland waterway regiments, the same method was adopted as in the organization of the forestry battalions. Enormous quantities of crushed rock were required for concrete and for the construction and repair of roads, but though

numerous quarries were available in the American areas, experienced quarrymen and quarrying equipment were lacking. Accordingly a special quarry regiment, the 28th Engineers, was organized in the United States in November, 1917, with a strength of 60 officers and some 1,500 men. A skeleton organization was formed by transferring a few officers and a small detachment of men from a road regiment, the new unit being raised to strength by giving commissions to quarry managers and superintendents and filling up the ranks with drafted quarrymen.

Spreading over almost the whole of France is a veritable network of navigable rivers and canals, of which the Engineers availed themselves to the utmost in the transportation of material and supplies. Transportation by the inland waterways was in charge of the 57th Engineers, this regiment being largely recruited from men who had had experience on the canals and rivers of the United States. In the days to come many are the tales that will be told by skippers of stern-wheelers on the Mississippi and captains on the Erie Canal of the days when they and their huskies of the Inland Waterways battalions moved the supplies for Pershing's men up the Seine and through the canals of the Marne and the Rhône.

To the dredging, dock construction, and stevedore regiments was assigned the gigantic task of dredging the channels and harbors of the seaports which the French placed at our disposal, of building wharves and berths for the reception of American ships, and of the transferring of the cargoes from ship to shore. The

magnitude of their task is shown by the fact that cargo shipments grew from 20,000 tons in July, 1917, to 1,000,000 tons in November of the following year, while the 23 ship-berths which the French Government originally assigned to us had nearly quadrupled when the Armistice was signed.

Unless you have marched with armies or trekked across hot and arid lands, you cannot know what it is to be thirsty—really thirsty, I mean; so thirsty that your tongue swells until it all but chokes you or lolls from your mouth like that of a panting dog. Water is infinitely more important to the success of a military operation than arms or ammunition; to a certain extent it is more important than food; for, though troops can fight for an amazingly long time on short rations, or even on no rations at all, they cannot fight without water. The vital importance of providing an adequate water-supply was learned by the French in Algeria and Morocco, by the British in India and the Sudan, where the deserts were strewn for miles with the bodies of soldiers who had died from thirst. In the Cuban campaign our armies had far more deaths from impure water than from Spanish bullets. During the Italian offensive on the Carso, that terrible plateau of sun-scorched rock which lies beyond the Isonzo, hundreds of men, Italians and Austrians alike, died from thirst, the Austrians being eventually compelled to retreat because the Italian artillery had destroyed the pipe-lines which supplied them with water. During the fighting on the Western Front dur-

ing the last summer of the war, when the semitropic sun of eastern France beat down on the heavy-laden backs of the panting, sweating men, when millions of feet and hoofs ground the roads to powder and filled eyes, ears, throats, and nostrils with the yellow, choking dust, when the air reeked with the mingled stenches of leather, gasoline, sweating horse-flesh, and human perspiration, and when, as the canteens emptied, the men peered anxiously over their shoulders for the company water-carts, thousands realized as never before the truth of Kipling's words:

> "When it comes to slaughter,
> You must do your work on water."

Now, when a hundred thousand men and thirty-five thousand animals are crowded into a sector perhaps three miles wide and seven miles deep, the problem of keeping those men and animals supplied with water becomes tremendous. The responsibility for supplying with water the troops in the field fell upon the Army Water-Supply Service, which, as might be expected, was a branch of the Corps of Engineers. The Water-Supply Service was really a wholesaler of water, delivery being made at "water-points," from which water was drawn directly by men and animals, the largest customers being, however, the ubiquitous two-wheel water-carts of the infantry and artillery. To supply these "water-points" every available source was utilized, springs developed, deep wells bored, village wells and cisterns cleaned out, streams purified and pumping-stations established, the aim being to

provide water within a mile and a half of every consumer at the front. Ordinarily two gallons of water per man per day were furnished at the front, this quantity being sufficient for drinking, cooking, and lavatory purposes, but during the enormous troop concentrations incident to the St. Mihiel and Argonne offensives this quantity had to be materially reduced, during those periods of stress and action the men having scant opportunity for either cooking or bathing. It was impossible, however, to reduce the quantity for the animals, for each of which eight to ten gallons had to be provided daily.

Even under battle conditions the purity of the water was the first consideration, for impure water can work far more havoc with an army than enemy shell. In order to provide against this contingency, mobile laboratories for water-testing purposes moved in the van of the armies, and during the drives the Water-Supply troops were provided with poison-testing kits, for, warned by the experiences of the British in German Southwest Africa, where wells were systematically poisoned by the enemy, we took no chances. Sources of supply were, wherever possible, protected, it being considered almost as serious an offense for a soldier to contaminate a water-supply as for him to sleep on post. Where water was found to be polluted, the troops, no matter how thirsty, were under no circumstances permitted to use it until it had been filtered and sterilized. It is a curious fact that the chlorine used in gas-shell to kill Germans was used by the Water-Supply Service in minute quantities to kill an

equally dangerous and far more insidious enemy—the microbic disease-carriers in the water. Special motor-trucks, equipped with pumping, filtering, sterilizing, and testing apparatus, time after time demonstrated that they were able to get into action and deliver pure water from a polluted supply *within thirty minutes* after their arrival.

In many cases the position of the troops and the nature of the terrain made it possible to deliver water only by hauling. This was done by means of trains of motorized water-tanks and by special tank-cars operating over the narrow-gauge railway systems, the tank trucks and cars being emptied into reservoirs built in strategic positions near the front. A common and quickly built reservoir consisted of a hole in the ground, a waterproof canvas lining, and a camouflaged cover. The lives of the tank-train truck-drivers were hard and exciting, for though the roads over which they had to pass in approaching the front were nearly always subjected to heavy shell-fire, there could be no let-up in supplying water for the troops on the firing-line. Most of the activities of the Water-Supply troops were between the locations of the light artillery and the heavy artillery, the men consequently working almost continuously within the areas under enemy bombardment. On one occasion, during the open warfare incident to the St. Mihiel offensive, the driver of a water-truck ventured so close to a German machine-gun nest that when he came back his tank was found to be better adapted for road-sprinkling than for water-transportation purposes.

It is scarcely necessary to remark that enormous quantities of material were required for the work of the Water-Supply Service, 60 miles of pipe and 300 gas-driven pumps being used during the St. Mihiel and Argonne-Meuse operations alone. As there were not enough Water-Supply troops—the 26th Engineers—for the needs of the army, it was found necessary to supplement their numbers with other Engineer units, motor-truck companies, and pioneer infantry, the Water-Supply Service of the First Army reaching a maximum of 3,500 officers and men.

One does not usually associate intelligence work with water-supply, yet the American Water-Supply Service had an intelligence section which was as efficient as that of any branch of the army. Information regarding the water-supply in the territory behind the enemy lines was gathered from all available sources, the *Wasserversorgung* maps captured from the Germans affording much valuable data, and the information thus obtained was published at frequent intervals, together with maps. The production of these water-maps finally became so highly developed that it was possible for the intelligence section of the Water-Supply Service to place full information at the disposal of the divisional intelligence officers within twenty-four hours after it had been received. So rapid was the American advance in certain sectors that scores of Boche pumping-plants were captured while still in operation, and turned to the task of supplying the thirsty Yanks. I might add that German prisoners, particularly of the corresponding enemy service, fre-

quently were as successfully pumped for information as the wells sunk by the enemy were pumped for water.

One of the most picturesque and interesting developments of the war—and, because of the secrecy which surrounded it, one of the least known—is the work of the flash and sound ranging section of the Engineer Corps. For the benefit of the uninitiated—and most people are uninitiated, so far as this phase of warfare is concerned—I might explain that flash-ranging means the location of an enemy gun or battery by the detection of the flash, and sound-ranging by the location of the sound. Flash-reading, as it is called, is carried on by means of two or more observers provided with powerful telescopes, who are stationed at known distances apart. By "spotting" the flashes of an enemy battery and reporting them, together with the exact direction at which they occur, and by using these readings as a basis, a simple calculation in triangulation will give the location of the gun. So highly has this flash-ranging been developed that a gun can now be located within five yards, when the "core" of the flash can be seen. In principle the process is extremely simple, but in practice it is complicated by the fact that the observers may not train their telescopes on the same flash, in which case the gun position calculated at headquarters from their telephoned reports will be in error. This difficulty is met, however, by providing each observer with an outpost switch-set, by means of which he can flash a miniature light at

the headquarters station at the instant he makes an observation, just as a light glows on a hotel telephone switchboard when a guest up-stairs rings for ice-water. When several of the observers flash their light simultaneously, it is assumed that they all probably caught the same flash, and their observations are then plotted. In other words, the line of sight of each observer is prolonged on a map until they intersect, the point of intersection corresponding with the location of the German gun.

Flash-ranging was also found to be of great value in checking the ranges of our own guns. If we were firing at a hidden target, a shell was timed so that it would burst when at the top of its trajectory. Observers would "spot" this burst, and if it was reported as being at the spot where calculations showed that it should occur, the gunners knew that they had the correct range.

Sound-ranging was carried on along much the same lines as flash-ranging, except that the readings were made by instruments instead of by observers. Large guns may be camouflaged so that their detection, either by aerial observation or by the flash of the gun when fired, is extremely difficult, but there is no known way to conceal the location of the gun from sound-ranging instruments, suitably placed and properly operated. This method became so highly developed that it was reported that during the latter months of the war over 80 per cent of the work of locating gun positions on the British Front was done by sound-ranging. The instruments used for this

work are of a highly technical nature and for their successful operation require a skilled personnel. Recording instruments, so delicate that their use heretofore had not been dreamed of outside of experimental laboratories and then only in the hands of men carefully trained in their operation, were set up on the firing-line and operated successfully under battle conditions, even when the air was quivering from heavy bombardments and the earth was shaking from the deluge of steel. The sound-receivers, or detecting instruments, are located well to the front, whereas the recording instruments are several miles in the rear. A sound disturbance due to the firing of a gun somewhere behind the enemy lines is transmitted through several miles of wire to the recording instrument in the rear, and the sound records received almost simultaneously from several detecting instruments are traced on a sensitized ribbon, or tape of photographic paper, or on a ribbon of smoked paper, depending on the type of instrument used. The intervals of time elapsing between the arrival of the various sound disturbances is used as a basis for determining the origin of sound which produced the records. By this means over 100 new German gun positions were located in a single day on the British Front. In fact, before the assault on Messines Ridge the British sound-rangers had located practically every German battery, so that the British gunners had their exact range when the attack was launched. When the Armistice put an end to hostilities there were in operation along the American Front some twelve complete American sound-

ranging sections, each covering a front of approximately five miles.

A sound-ranging section on an active sector of the American front usually consisted of four officers and from eighty to a hundred men, one-half of whom were specially trained in the care of instruments, observation work, and mathematical computations. On a stable sector the personnel of the section could, of course, be considerably reduced.

The principles, methods, and instruments employed by the sound-ranging section of the Engineers for locating active enemy batteries or for ranging the friendly artillery on any objective whose map-location was known were of an extremely technical nature and not easy of comprehension by a lay mind. So for the information of those readers who are technically inclined I have asked the Engineer officer who was in charge of sound-ranging in the A. E. F. to explain in the simplest possible language how the work was done. Here is his explanation. Make the most of it.

The principle employed by the sound-ranging section of the Engineers for locating active enemy batteries or for ranging the friendly artillery on any objective whose map co-ordinates are known is the following: The time of arrival of the sound from an enemy gun (or from the burst of the shells from the friendly artillery) at three surveyed stations inside the friendly lines determines the position of the source of the sound if simple corrections are applied for the temperature of the air and the direction and velocity of the wind. For example, if the three surveyed sta-

tions are on an arc of a circle and the sound of the enemy gun arrives at all three stations at the same time, then the gun must be at the centre of the circle. If the sound arrives first at the westernmost station and last at the easternmost, then the gun must lie to the westward of the centre. If the sound arrives earliest at the middle station and later at the flank stations, then the gun must lie between the centre of the circle and the stations. In practice six stations are used to insure greater accuracy, and graphical methods of computation are employed to shorten the time of calculation. Accuracies of fifty yards are regarded as average, and from one to two minutes for calculation are usually needed.

A somewhat different form of sound-ranging is used for the detection of aircraft at night. The apparatus for this aerial sound-ranging consists of large sound-gathering instruments which are used to direct search-lights in the location of approaching airplanes. When a bombing-plane approaches at night the hum of the motor can be heard at a distance of from one to three miles or more, depending upon the direction of the sound and the atmospheric conditions. The direction of sound, however, particularly when it originates in the sky, is illusive to the naked ear and search-lights were obliged to sweep the heavens in the general direction from which the airplane was believed to be approaching, in an endeavor to locate it. By the use of these detectors, however, the sound of an airplane can be detected at a considerably greater distance than by the naked ear, and, what is even more important,

its direction can be determined within a very small angle—less than five degrees. In this way the area over which the search-light has to sweep is greatly reduced, and the chances of locating the aerial marauder are enormously increased.

Extensive experiments have been conducted in this country by the Engineer Corps in the development of these aerial sound-detectors. One form consists of four horns, two in a vertical and two in a horizontal plant, with listening-tubes leading from the small ends to the receivers of the observer's head-set. These horns are mounted so as to permit rotation on a horizontal shaft and turning on a plane-table, the whole being supported on a sort of steel tower which, owing to its height and the fact that it cannot easily be moved, affords a rather conspicuous target for the enemy. The obvious disadvantage of this type is recompensed in a measure, however, by its accuracy and by the fact that it will so magnify a sound that the operators can hear the tick of a watch a hundred and fifty yards away. This apparatus is, however, large and cumbersome, and though excellent for seacoast and fortress defense, is not adapted for use in the field, where extreme mobility is required. For this latter purpose paraboloid sound-reflectors have been developed. These paraboloids are about nine feet in diameter, made in sectors of material similar to beaver board, and look like enormous editions of kettles used for boiling soap. They can be taken down and packed into small space for transportation, and are easily set up; being mounted on Ford chassis, they can go

anywhere that a "flivver" can go. The paraboloids, like the horns, are directed by balancing the sound so that it is equally audible in both ears. These instruments have a sensitiveness double that of the unaided ear and by means of them a sound can be located to within three degrees.

When the officer in charge of one of these sound-detectors hears through the receivers of his head-set the rhythmic hum which denotes an approaching airplane—and I might mention, parenthetically, that experienced observers can tell with almost absolute certainty not only the nationality of the approaching machine but even the type and power of its engines—he orders several sound-readings to be taken at definite intervals of time. With these readings as a basis for the calculation, the probable location of the airplane at the end of the next time interval is plotted and the search-light is flashed in that direction just long enough to locate the machine. Quick work is required, however, for the airplane often travels at a hundred miles or more an hour and may abruptly change its course at any moment. Then, the plane once spotted, the beam of the search-light never leaves it, and the waiting crews of the antiaircraft guns get to work. Experiments are now being conducted to enable these listening devices to be used in synchronization with search-lights, so that, when the light is flashed, the airplane will be within the beam and no indication of the presence of the search-light will be given the aviator until he finds himself illuminated as a spot-light follows the movements of a dancer on a darkened stage.

In the autumn of 1917 the National Research Council, at the request of the Chief of Engineers, inaugurated an extensive series of search-light investigations, which, thanks to the enthusiastic co-operation of scientists, manufacturers, and certain government bureaus, resulted in a number of remarkable developments. Eighteen different kinds of search-lights were developed during these experiments, the first being placed in operation in France in October, 1918. This represented an entirely new form of light, more powerful than any heretofore produced by any nation. It weighs about one-eighth as much as the most powerful search-light theretofore produced, costs only about one-third as much, and has about one-quarter the cubage. Other improvements now in progress give assurance that its range will be doubled, its cost still further reduced, and its mobility greatly increased. And, what is of almost equal importance, the designs are now becoming so simplified that production need no longer be confined to highly specialized shops, but may be distributed over the country to all classes of machine manufacturers, thus making it possible to produce a large quantity in a relatively short time. With this new equipment the United States will possess a search-light having an effective range approximately twice that of the best search-light produced before the war, with four times as great a field. Two features of the latest types of lamps are particularly worthy of notice. These are, first, the "dish-pan" type of light, the chief characteristic of which is that it has no lens; and, second, the metal mirror, which

is much more easily manufactured, is far less fragile, costs only a third as much, and possesses almost as great reflecting qualities as the glass ones.

The search-light used by the American forces for antiaircraft work is the heavy 60-inch seacoast type —the largest light known—lightened and modified for use in the field, with a range of practically 30,000 feet. As the result of recent experiments it has been found that the visibility at 12,000 feet was 85 per cent, while at 15,000 feet, or nearly 3 miles, it was 43 per cent. In order to obtain these standards of comparison for visibility for search-lights, an aviator was directed to fly back and forth through the beam a certain number of times. If the observers on the ground recorded the full number of passages across the beam, 100 per cent was registered, this occurring regularly at 5,000 feet, and in most cases during tests at 8,000 feet. The percentage of visibility was, in other words, the number of times the airplane was seen to the number of times it crossed the beam.

When warfare of movement becomes stabilized into position or trench warfare, it is almost certain that, sooner or later, one side or the other will resort to some form of underground attack. To permit of this subterranean warfare, certain conditions are requisite: the lines must be fairly close together, the level of the ground-water must be deep, and the ground itself must not be too hard. These obstacles to successful mining are not insuperable, however, for, preparatory to their assault on Messines Ridge, the British

drove a tunnel which was a mile in length, and on the Carso I saw Italian engineers driving their galleries through solid rock. France and England early recognized the importance of this form of warfare and organized their miners accordingly, and, upon our entrance into the war, we too organized and sent to France a mining regiment—the 27th Engineers. It is estimated that by the summer of 1918 there were upward of 40,000 skilled miners on the Western Front, these soldiers of the pick and drill having been brought from the remotest corners of the earth —from the Yukon, the Rand, and the Congo, from Mexico, Australia, and California. In my "Vive la France!" I told, if I remember rightly, of the Cornish miners, known as "kickers," who lay on their backs, as they do in the tin mines in Cornwall, where the galleries are so low that there is no room to swing a pick, and kicked away the earth by means of a sort of spur attached to their heels.

The officers of the American mining regiment were engineers who had had practical experience in all those far-off regions where men seek their fortunes in the earth. One of them, a young lieutenant, was diamond-mining in the Katanga district of the Congo when word reached him by native runner that the United States had decided to take a hand in the Great War. It took him four months of uninterrupted travel by horse, wagon, rail, and boat to reach the United States and offer his services to the Chief of Engineers. Another of our mining officers was a prisoner of the revolutionists in Mexico when the rumor penetrated to his

prison cell that the United States had gone to war. That night he overpowered his guards, scaled the prison wall, made his way on foot across northern Mexico, the journey being relieved from monotony by several hairbreadth escapes from bandit bands, and reached the border in time to join the Engineers and go to France with one of the first contingents.

In former wars military mining was almost wholly confined to siege operations; that is, driving galleries under fortified positions and blowing them up. But the Great War developed an entirely new system of mining tactics, which included frontal and flank attacks, raids, enveloping movements, and other phases of war as fought on the surface of the earth. "Unlike the soldier who fights above ground," explained a mining officer, "the miner has to be prepared for attacks not only against his front and flanks, but for assaults which may come from overhead or from underneath. In other words, he has four flanks to defend instead of two."

A typical mining position, such as would be prepared on an active sector of the front, would consist of an upper level having a series of forked galleries, known as "feelers," with geophone listening-posts at their extremities, and a deeper level, with numerous "fighting branches" projecting from it, to protect the lower flank. Just as the sentries in the trenches strained their eyes to detect any ominous figures in the darkness of No Man's Land, so the mining sentinels, crouching over their geophones in the headings of dim-lit galleries, strained their ears to catch the faint sounds

which gave warning that the enemy was approaching underground. The geophone, which has proved of incalculable value in mining warfare, is an instrument for augmenting small sounds coming through the ground. The American geophone, which is a highly sensitive, extremely simple, and easily portable instrument, is in no sense an electrical device, resembling, rather, the stethoscope used by physicians for testing the lungs. In mining operations two geophones are used, one for each ear, the instruments being so sensitive that the sounds caused by a fly walking on the wooden support of the geophone appear as loud as the tramp of a horse on the floor of a stable. If a sentinel on duty in an underground listening-post caught through his geophone a sound which was more distinct in, say, his right ear than in his left, he gently shifted one of the instruments, inch by inch, until the sound was the same in both ears. Then, by means of a compass, he took the magnetic bearing of a line perpendicular to that passing through the two geophones, which would give the direction from which the sound came. Meanwhile sentries in the other listening-posts were doing the same thing, so that, by the co-ordination of their reports and by triangulation, the enemy's gallery could be located within a few yards.

If the mining officer was convinced that the enemy was driving a gallery for the purpose of putting a mine under his position, two courses of action would be open to him. He could remain on the defensive and check the enemy's advance by the use of "camouflets," this being the name applied to explosive charges

which expend their force laterally, thus destroying the enemy's gallery without causing a crater; or he could resort to strategy and engage the enemy's attention at one point by exploding camouflets or by working noisily, and under cover of this diversion drive a fighting gallery toward his flank elsewhere. If, instead of being content to remain on the defensive, the officer in charge of mining operations decided to assume the offensive, he would engage the enemy's attention at one point, either by exploding camouflets or by working noisily, and at the same time drive a fighting gallery toward his adversary's flank. In this latter case the most profound silence had, of course, to be enforced in the fighting branch if the enemy's geophones were not to give warning of its approach. No talking was permitted, the men wore felt-soled shoes and worked with trowels instead of picks, and the earth was carried out in cars with rubber tires. So silently were the operations in the fighting branches conducted that they would frequently break into the enemy galleries without the slightest warning, whereupon would ensue a struggle fought scores of feet beneath the surface of the earth, by combatants armed with picks, pistols, bombs, and knives, and illuminated only by flickering miners' lamps—a battle so weird and strange in its character and setting that it seemed like the creation of a motion-picture writer's brain.

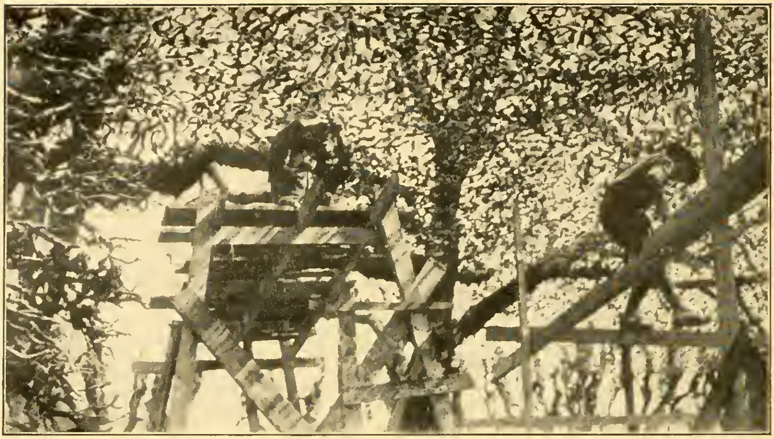
One of the essentials for the success of a mining operation is the concealment of the spoil—*i. e.*, the excavated earth—which, if piled in a heap at the entrance to the workings, would almost certainly be photo-

graphed by aerial observers, thus informing the enemy, as unmistakably as though it were announced on a placard, that a mining gallery was being driven. The French, in order to hide the spoil from their mining operations, conceived the ingenious plan of digging a shallow trench, usually only a few inches deep, and lining it with black paper, so that when photographed from an airplane it produced the effect of the black shadow cast by a trench of customary depth. They would then distribute the spoil from their subterranean galleries along the sides of this false trench, so that it appeared in the photograph to have been thrown up from it.

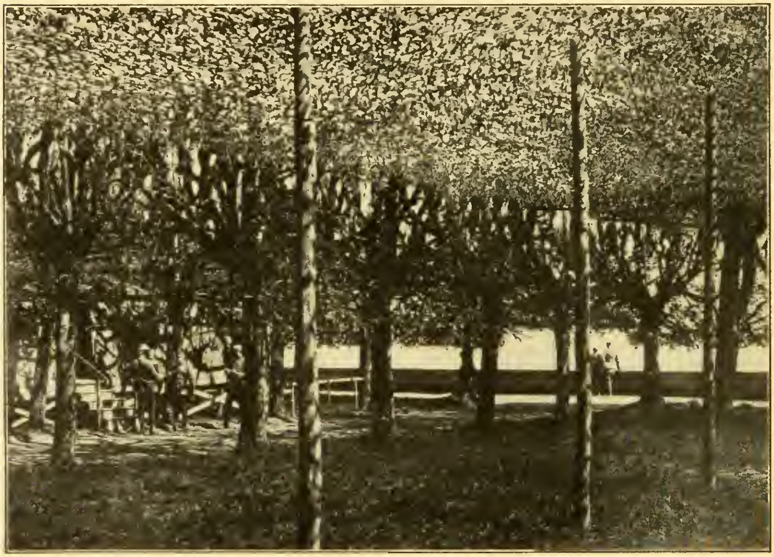
Dugouts have become such a commonplace in the past four years that few, save the miners themselves, gave much thought to or had more than the haziest ideas of the time, skill, and labor required in their construction. Take yourself, for example. You have read about dugouts and seen pictures of dugouts and have probably had relatives or friends living in dugouts. How long, then, think you, would it take a force of skilled miners to complete a front-line dugout large enough to accommodate a half-platoon? (For your information I might explain that such a dugout is 35 feet long, 9 feet wide, and 6 feet high, with 17 feet of overhead cover.) Using all the men that could be employed, and working from nightfall until dawn, it would require at least three months to complete such a dugout. If in the rear area, where the men could be worked continuously in shifts, it could be completed in about thirty days.

NEW TYPE OF SEARCH-LIGHT USED IN THE AMERICAN ARMY.

The steel tower is collapsible and light and, being mounted on a motor-truck, is extremely mobile.



Constructing the screen.



The screen as it appeared upon completion.

CAMOUFLAGING A DIVISIONAL HEADQUARTERS IN THE TOUL SECTOR.

A recent and little-advertised development of trench warfare was the introduction of "mobile charges." These consisted of packages of high explosive in ten, twenty, or thirty pound sizes, which were used by assaulting troops for destroying dugouts, much as depth bombs were used by the navy to destroy submarines. With the increasing use of mobile charges it became necessary to design dugouts which would be proof against them. In this work, which was carried on by the Mining School, extensive use was made of dogs, experiments having shown that explosions which will rupture the lung-tissues of a dog will similarly affect those of a human being. Thanks to the knowledge thus obtained at the cost of canine lives, a type of dugout construction was perfected which afforded the occupants comparative immunity from mobile charges and hand-grenades. An ingenious receptacle for this latter form of enemy visiting-card was the "bomb-pit," which was a sort of small cistern, built at the foot of the dugout stairs, into which a hand-grenade would fall and explode harmlessly.

Though it has no direct relation to the work of the American Mining School, I might mention, as an illustration of the part played by miners in the great conflict, that when the British in 1917 blew off the entire top of Messines Ridge prior to their assault on that position, 19 mines, containing a total of 950,000 pounds of ammonal—equivalent to 1,580,000 pounds of dynamite—were exploded simultaneously. A single one of these mines contained 95,000 pounds

of ammonal and made a crater 186 feet wide and 125 feet deep.

Though few activities of the Engineers were more important than the work of the Camouflage Section, and though certainly none was more picturesque or interesting, it is with some diffidence that I introduce the subject, for I am perfectly aware that American readers have been, to make use of a British colloquialism, "jolly well fed-up" on everything pertaining to camouflage. The point is, however, that they have been largely "fed-up" on misinformation. They have read hundreds of magazine articles and newspaper stories about fake trees and papier-maché horses and the like, but of the real work of the Camouflage Corps —which, as an American general remarked, was "as practical as machine-guns and as necessary as ammunition"—they have heretofore been permitted, for quite obvious reasons, to know next to nothing. Certain camouflage operations on the American Front were of such vital importance to the success of our armies that, far from acquainting the public with them, they were veiled in the profoundest mystery.

Military camouflage is a development of the Great War and has, therefore, no history and little literature. It differs from the purely scientific work of engineering, which has few variants and in which nearly all problems can be worked out by formula, in that it has countless variants of light, color, and position, and each problem of concealment is an individual one. Upon the entry of the United States into the

war, much study was devoted to French and British camouflage methods, both in the factory and in the field. The British, it was found, did nothing without the most careful scientific investigation, which included aerophotography of all materials, while the more careless and temperamental French relied rather on their innate artistic sense of form and color. By combining the best features of both systems and strongly tincturing them with American energy, ingenuity, and manufacturing methods, our Camouflage Service soon came to be recognized as the best equipped and most efficient in the Allied Armies. At Dijon, in the Department of the Haute-Marne, we established a huge plant, known as the Central Camouflage Factory, where a hundred soldiers and some nine hundred Frenchwomen were employed in the production of materials, while at the Army Camouflage School of Fort St. Menge, near Langres, practical instruction was given in the use of these materials in the field.

When the war ended, the American Camouflage Service consisted of a battalion of the 40th Engineers —which was on the point of being expanded into a regiment—under the command of Lieutenant-Colonel H. S. Bennison, with Evarts Tracy, one of the foremost architects in America, as major. Captain Homer Saint-Gaudens, a son of the famous sculptor, was in charge of the camouflage work of the Second Army, and Captain John Root, whose father was architect of the Colombian Exposition, was in charge of all camouflage work for the army artillery, he being largely responsible for the remarkable developments in this

branch of warfare. The director of the Camouflage School at Fort St. Menge was Lieutenant Wilford S. Conrow, the noted portrait-painter. Another officer of the battalion, Lieutenant Harry Thrasher, a graduate of the Ecole des Beaux-Arts and a winner of the Prix de Rome, was killed while doing camouflage work at Fismes, as was Sergeant Everett Herter, a son of Albert Herter, the artist. Because of the exacting nature of its requirements, the Camouflage Service had, perhaps, a more highly educated enlisted personnel than any other organization in the army. Among the men wearing the uniforms of privates in the corps was the landscape-architect who laid out the grounds of the San Diego Exposition, the stage-manager for Maude Adams, the head property-man of the Universal Film Company, and Louis Tiffany's chief designer. One of the instructors at the school was a successful osteopath who in his younger days had been a scene-painter; another was a sculptor whose statues may be seen in many American museums and parks.

Figures are, as a rule, dry reading, but they provide the best means I know of giving some idea of the magnitude of our camofleurs' operations. During the summer of 1918 the Camouflage Section used materials *per month* as follows:

12,000 fish-nets.
50,000 pounds of wire.
700,000 gallons of paint.
2,160,000 square yards of poultry-netting and approximately 1,000 acres of burlap.

The best and most concise rules which I have seen for the erection of camouflage and for the enforcement

of camouflage discipline are contained in secret instructions issued in July, 1918, by the commander of the German First Army. They read as follows:

CAMOUFLAGE

Translation of a German Document (from French IV Army Bulletin, August 8, 1918)

1st Army
Command of the Aviation Service
Ia–Ib

ARMY HEADQUARTERS,
July 1, 1918.

I. ESSENTIAL POINTS IN THE CONSTRUCTION OF POSITIONS.

(*a*) *General.*

1. Camouflage will be completed before undertaking the work.
2. Camouflage will be sufficiently extensive in order that all the work required may be carried out under its protection.
3. Faulty installation will be left in place as dummy work and be begun over again at another point with the necessary prudence.

(*b*) *Tracks.*

1. Tracks must be as few as possible and have a natural appearance. It is best to avoid all tracks by building the position on roads already in existence.
2. Provide fixed access for everybody. If necessary, stake the paths out by means of wire.
3. Extend indispensable tracks beyond the position as far as the dummy work.
4. Use furrows as paths, do not go across fields.
5. Do not dump materials in the immediate neighborhood of the position.

(*c*) *Color of the Camouflage.*

1. Harmonize the color of the camouflage with the ter-

rain. Green camouflage in meadows, brown in ploughed fields, white in quarries.

2. The upper surface of the camouflage will be alternate light and dark tones; grass, reeds, hay, or branches fixed in iron wire, etc.
3. Renew the camouflage in proper time; the grass and branches fade quickly and appear light and not dark on the photographs.
4. The position must not extend partly over one field and partly over another, as two fields are seldom of the same color. The furrows will be reproduced in the camouflage.
5. Camouflage materials, such as the sod removed and small trees, will be taken at a distance of at least three to four hundred meters from the position; place a dummy work at a sufficient distance in order that it does not reveal the true position.

(*d*) *Forms of Camouflage.*

1. Do not raise the height of the camouflage needlessly; the higher it is the more shadow it throws. Raise it by means of posts during the work; bring it down by day and lay it flat if possible; cover mainly the entries and exits.
2. Do not make a heap of the earth removed but scatter it immediately.
3. There must be no fresh cuts visible, as marked contrasts result from it between the light and dark surfaces, the latter appearing as deep shadows on the ground.
4. Avoid regular shapes and rectangular outlines.
5. Do not change natural shapes. Positions in fills and embankments must not change the form of the fill or embankment.
6. Use the roads, fills, embankments, slopes, sunken roads, edges of woods to greater extent. Deceive the enemy by false tracks ending in woods.

II. MAIN INSTRUCTIONS FOR COLUMNS.

(*a*) Resting columns, location, and nature of halting-places.

The most important thing is that the halting-places be of irregular form.

1. It is best to distribute the columns irregularly under trees of gardens, avenues, roads, and courtyards, even if not very dense.
2. The camouflage of wagons or artillery pieces by means of branches does not secure them from reconnaissance by airplanes, when the column is in the open on light-colored ground, as, for example, on dry roads. Shadows enlarge in a surprising manner.
3. In villages, keep close to the houses, walls, enclosures of gardens and hedges, but, if possible, with irregular distribution. The best side is always the north side of houses, walls, etc., on account of the shadow.
4. In small courtyards the wagons are lined up one beside the other and the tarpaulins joined in order to make a roof. This appears as a smooth and very natural surface on the photograph, which does not attract the enemy's attention.
5. Lessen the tracks, if possible. Do not widen the roads of approach uselessly. Follow the track. Mark out footpaths, staking them out, if necessary, by wire.

(*b*) Troops on foot, wagons, and artillery columns on the march.

1. Even at night make more use of tracks which are generally dark; the columns can then with difficulty be observed by airplanes; on the other hand, columns on roads which appear light can be seen even at night.
2. Infantry columns will be divided into small groups distributed in depth and advance along the shady side of roads.
3. When airplanes use light projectors at night keep in the shade of trees or buildings.

III. General Rule.

When surprised by airplanes, either by day or by night, use

all natural shade provided by trees, embankments, houses, etc., and remain motionless.

By Order of the General Commanding the Army.

Chief of Staff.

(Signed) Faupel, *Lieutenant-Colonel.*

So great, indeed, was the importance attached to camouflage by the German High Command that, during the last year of the war, there was attached to every German division a "security officer" whose duty it was to enforce the rigid observance of camouflage discipline. In many cases these security officers kept a watch on their respective division from observation-balloons. They were answerable only to Great Headquarters and were empowered, I understand, to recommend the removal of all officers up to and including generals of division for infraction of the rules for camouflage discipline as laid down by Ludendorff.

Camouflage, it should be kept in mind, is of two kinds—negative and positive. Negative camouflage consists in the concealment of troops, trenches, mine-shafts, battery positions, ammunition-dumps, hangars, or other objects, knowledge of whose location must be kept, if possible, from the encmy. Positive camouflage, on the contrary, consists in the imitation or suggestion of troops, trenches, batteries, etc., in certain locations, when, in reality, there is nothing of the sort there, in order to deceive and bewilder the enemy. It occasionally became necessary, for example, to convince the Germans that a large troop movement was in progress behind a certain sector of the front, whereas the real movement was taking place scores of miles

away. If it was desired to suggest a movement by rail, smoke-pots with clouds of dense black smoke bellying from them were placed on flat cars and moved about from point to point on the military railways. German aviators, observing these columns of smoke at numerous points along the railways, naturally assumed that they came from locomotives hauling troop-laden trains and promptly reported that large bodies of troops were apparently being moved by rail behind the American lines. Thereupon the German commander would rush up his reserves to resist the attack which he believed to be impending. Or, if it was desired to imitate a troop movement by road, the camouflage officer would requisition large numbers of Fords, which would be driven madly along the roads, dragging bundles of brush behind them. The great clouds of dust which thus suddenly appeared on the highways naturally suggested to the German observers that the *verdamnte* Yankees were rushing large bodies of troops to the front by bus or motor-truck. Fooling Fritz was an amusing game while it lasted.

This latter ruse, I might mention parenthetically, was not original with the Americans, for President Diaz, of Mexico, once related to me how, when he and his little band of patriots were being hotly pursued by the French forces sent to Mexico to keep Maximilian on his unstable throne, he ordered his vaqueros to cut bundles of mesquite and drag them behind them by their lariats. It was in the dry season, and the dense clouds of yellow dust thus stirred up convinced the French commander that the Mexican force was far

stronger than it really was. He thereupon precipitately abandoned the pursuit and a few weeks later General Diaz, having gained the breathing-spell necessary to augment his forces, fought and won the decisive battle of Puebla.

It has frequently been said that the camera does not lie, but such assertions were made before the Camouflage Corps commenced its operations. Thereafter the negatives brought in by the German airmen began to prove so unreliable that the officers whose business it was to interpret them never knew whether they were telling the truth or not. For example, it frequently became necessary after heavy bombardments in which long stretches of entanglements had been destroyed, to convince the enemy that the wire had been repaired. This illusion was accomplished by the simple stratagem of driving stakes into the ground and festooning them with fish-nets, for, in a photograph taken from the sky, fish-nets thus arranged are indistinguishable from wire. If such ruses are to deceive the enemy, however, as much attention must be paid to detail in their execution as David Belasco pays to detail in the production of a play. On a certain British sector a not overintelligent subaltern was ordered by his battalion commander to take a working party and put out some 500 yards of this imitation wire, as there was reason to believe that the Huns, thinking the sector unprotected by entanglements, were preparing to make an attack. Now it is some job, even for a large and well-trained working party, to put out 500 yards of wire in much under a day. Heedless of such

minor details, however, the lieutenant gayly slammed in his stakes and spread his fish-nets as fast as his men could work, "wiring" the 500 yards of front in little more than an hour. From high in the blue German airmen photographed the proceeding. When one set of photographs showed a sector destitute of wire and another set of pictures, taken an hour later, showed the same area with a complete system of wire entanglements, the suspicions of Von Hindenburg's intelligence officers were naturally aroused, and the next morning at dawn the Germans launched their attack. In camouflage work one can't afford to be slipshod.

The most elaborate camouflage works can be rendered utterly useless, however, by the carelessness of a single soldier, for there is little that escapes the eye of the airman's camera, particularly when it was fitted, as during the latter days of the war, with a stereoscopic attachment. I remember that in one of the Champagne sectors the Germans had installed a battery of heavy guns which were so ingeniously concealed that the French were unable to locate them. It was believed that they were hidden somewhere in a fringe of woods along a stream, but though there was a considerable area of cultivated land beyond the woods, the aerophotographs of it showed nothing which would suggest a path such as would be made by artillerymen going to and from their guns. One day, however, a new batch of plates, upon being developed, showed a dim gray line, faint as the shadow of a hair, leading across this cultivated area to a small wood on the bank of the stream, where a battery might easily be con-

cealed. Upon studying an enlargement of the picture the intelligence officers became convinced that the shadowy line on the negative really represented the trail left by a soldier crossing the field. Proceeding on the surmise that the soldier was an artilleryman going up to his gun-position, the French gunners registered on that particular patch of woods the following morning, whereupon the fire from the concealed battery abruptly ceased. German prisoners captured a few days later explained how the secret of the battery's position had been kept so long. The German security officer had issued orders that the artillerymen must under no considerations walk across the fields in order to reach their guns, but that they must instead follow a much-used highroad until they reached a bridge over the stream, drop from the bridge into the water, and wade up the stream until opposite their position. But one night an artilleryman, in a hurry to reach his battery and confident that the tracks left by a single man could do no harm, took a chance and a short cut across the forbidden field. I have told you what happened to his battery as a result of his carelessness. Knowing something of German discipline, I can imagine what happened to him.

But it was not often that the Germans were caught napping, and so ingenious were some of their ruses and stratagems, that it required an intelligence officer with the imagination of a Sherlock Holmes to keep up with them. During the operations on the Flanders front a British aviator brought in some photographs of a certain area behind the German lines. The intelligence

officer whose duty it was to scrutinize them detected a suspicious something which he was convinced was a cleverly camouflaged German battery, but though it was in the midst of open country there was no suggestion of a path leading to it. After studying the photographs for several hours he suddenly exclaimed:

"I have it! They get up to the guns on the covers of biscuit-boxes."

"What do you mean?" his chief asked curiously.

"It's as plain as the nose on your face," explained the youngster. "The Boche knows jolly well that if he walked across that open ground his tracks would show up in our air photos. So when he wants to get up to his battery he gets a couple of wooden biscuit-box covers and ties strings to them. He stands on one cover and throws the other ahead of him, then stands on that and drags up the first cover by means of the string and repeats the operation. Deuced clever of the beggars, I call it."

And, as subsequent events proved, the intelligence officer was right in his deduction. That was precisely what the Germans had done.

By far the most important work of the Camouflage Corps was the construction of "flat-tops" and "false contours." A flat-top, I should perhaps explain, is a screen for concealing a gun from enemy observation. It consists of a fish-net, usually 37 feet square, into the mesh of which are woven and knotted narrow strips of burlap of colors to blend with the vegetation of the region where the flat-top is to be used. The interwoven burlap becomes gradually

thinner as the edges of the net are approached, so that no sharply defined shadow may be cast. Every piece of artillery, large and small, in the A. E. F. had its own flat-top, which accompanied the gun everywhere, being stretched above it, like a canopy, when the piece was in action, at other times being rolled up and carried on the limber. A somewhat similar device was also provided for the concealment of machine-guns. It resembled one of those huge umbrellas used in summer on delivery-wagons, and, like an umbrella, it could be quickly raised or lowered. It was the intention of the Camouflage Corps, had the war continued, to provide one for every machine-gun.

A false contour can best be described as the prolongation, by means of burlap spread over a sort of wire trellis, of a ridge, promontory, or hill. It being desired to place a battery at the foot of a hill and at the same time conceal it from enemy observation—which included photographs taken from enemy airplanes—the Camouflage Corps would first of all erect a light wooden framework, something like that of a grape or rose arbor, but conforming to the general contour of the hill. Over this framework was stretched wire netting, which supported, in turn, a finer mesh of chicken-wire, into which were woven strips of burlap dyed so as to exactly match the color of the hill itself. The space beneath this burlap screen provided perfect concealment for anything up to a battery or a battalion, while so closely was nature imitated in the shaping and coloring of the false contour that photographs taken by enemy flyers would show only

SUITS KNOWN AS CAGOULES.

These suits are made of burlap and painted to match the vegetation and were frequently used by American snipers and raiding-parties.

Photograph by Signal Corps, U. S. A.

As the enemy had this road under direct observation, traffic along it was concealed by means of burlap screens.

Photograph by Signal Corps, U. S. A.

An overhead road screen made of burlap strips and chicken wire.

THE WORK OF THE CAMOUFLAGE CORPS.

an innocent hillside, with not enough vegetation to provide cover for a sniper. The burlap used in the construction of these false contours was frequently "slashed," after the fashion of foliage-drops in theatres, and was dyed in a great variety of shades, all of which were standardized and could be ordered by number. There were burlaps slashed and dyed to imitate ploughed fields, grain-fields, roads, lawns, quarries, water, rocks, and spring, summer, autumn, and winter foliage; in short, every phase of nature as found in the zone of operations.

The first time I visited the big warehouse of the Camouflage School at Fort St. Menge, I thought for a moment that I was back in the old Eden Musée which used to stand in West 23d Street, for stacked against the walls were scores of lifelike silhouettes of soldiers charging with fixed bayonets, while the shelves were lined with soldiers' heads beautifully executed in papier-maché. The silhouettes, which were of painted canvas mounted on light wooden frames, were used in the so-called "Chinese attacks"—an idea which we borrowed from the British. When it was necessary to ascertain how quickly the enemy could switch on his artillery-fire in a certain sector, or the location of his batteries or machine-guns, a hundred or more of these silhouettes would be carried out into No Man's Land under cover of darkness and laid down in front of our wire in such a manner that they could be pulled upright by means of cords running back to our trenches. Just at daybreak, at that hour when objects are still indistinct and when the nerves of the men in the trenches

are at the greatest tension, a signal would be given, the cords pulled, and a long line of what appeared to the startled Germans to be charging Yankees would suddenly appear in the mist overhanging No Man's Land. Instantly the German trenches would crackle and blaze with musketry, the concealed batteries and machine-gun nests would betray their positions by going into action, and by the time the Huns discovered the hoax that had been played upon them, our observers had obtained the information which they required. Sometimes, in order to further chagrin the Boche, the silhouettes would be left standing.

The papier-maché heads to which I have already referred were used for the purpose of locating German snipers. When a sniper became particularly annoying and defied all attempts to locate him, the camouflage officer attached to the division would be summoned. Under his direction a papier-maché effigy of a soldier's head, steel helmet and all, made so as to move up and down in wooden guides, would be set up in that part of the trench which the sniper had been annoying. At intervals the head would be slowly raised and lowered, so that from the outside of the trench it looked precisely like a soldier peering cautiously over the parapet. Sooner or later the hidden marksman would send a bullet through the careless Yankee's brain. The neat hole drilled through the papier-maché showed the exact direction from which the bullet came, and by inserting in the hole a tiny telescope, no larger than a pencil, and looking through it by means of a periscope, the loophole from which the sniper was firing could be

located. In one case a sniper was found to be firing through a hole bored in the heel of an old boot, apparently thrown carelessly onto the glacis.

Though I have described at some length the use of silhouettes and papier-maché heads because they are picturesque and interesting phases of modern war, it should be borne in mind that they were designed to meet exceptional conditions, that they were used infrequently, and that they were in no sense typical of the enormously important work of the Camouflage Service.

In the foregoing pages I have sketched the multitudinous activities of the Engineers only in the barest outline. To attempt to compress the story of their achievements into the limits of a single chapter would be absurd, so I have dwelt only on the most picturesque and unusual phases of their work—the high spots, as it were. There is much that I have left unsaid, not because it is not worth saying, but because I have no space in which to set it down. The stories which I have had, perforce, to leave untold would in themselves fill a volume. Among their other accomplishments the Engineers designed a portable steel bridge, made up in sections so that it could be transported on trucks, and so designed that it could be bolted together, which could sustain a load of thirty tons over a span of ninety feet. These bridges were used all along the fighting front, as our forces advanced, to replace the bridges destroyed by the retreating Germans. They had under construction, when the war ended, a raft designed

for the transportation of the heaviest pieces of mobile artillery in existence—by means of which, had necessity required it, we could have ferried our giant howitzers across the Rhine. The portable floating footbridges—passarelles—which our troops used in crossing the Meuse and the adjacent canals under fire were invented by an officer of Engineers. The Engineers threw one of them across the Canal de l'Est, near Dun-sur-Meuse, under a shell and machine-gun fire so heavy that it was twenty-six hours before the infantry could cross it. The Engineers have invented a very ingenious and remarkable device whereby search-lights can be operated from a distance, thus making it possible for an officer to control a battery of scattered search-lights just as the man in a signal-tower controls, by means of levers, the switches in a railway yard. The corps has perfected a blasting machine for demolition work which destroyed ruins faster than the Huns could make them. Military operations are absolutely dependent upon maps and plenty of them. The Engineers met the demand by erecting and operating in France a larger map-producing plant than was possessed by France herself or any of the Allies. In order to provide a more rapid means of obtaining topographical information, Major James W. Bagley, of the Engineers, invented an aerial cartograph or mapping camera, which takes three pictures at a time from an airplane, mapping a strip of territory three and a half miles wide at 5,000 feet elevation, the series of pictures thus taken forming a mosaic map of the country over which the airplane has flown which is as accurate and

far more detailed than a map drawn from surveys. This invention opens up an entirely new field for the use of airplanes and a possible revolution in former methods of mapping. The Engineers likewise produced portable machine, blacksmith, and lithographic shops, the capacity of the portable lithographic truck-sets furnished the 29th Engineers—the Surveying and Printing Regiment—being greater than that of the permanent map-reproduction plant of the Geological Survey in Washington. Mobile sterilizers, water-tanks, job-presses, photographic laboratories, derricks, pile-drivers, road-sprinklers, and oilers were all asked for by the A. E. F., whereupon the Engineers designed them and shipped them to France.

I fully realize that what I have written in the preceding pages contains no mention of the supply work performed by the corps in the United States, which was so enormous that 27 per cent of all the tonnage shipped to France up to the signing of the Armistice was from or for the Engineers. Furthermore, I have touched only here and there upon the activities of the corps oversea, where in addition to the enormous amount of engineering work which had to be done with the armies, including fighting, the construction of fortifications, and the building of roads, railways, and bridges, it executed an incredible amount of general construction, such as docks and warehouses, railroad yards and railroad bridges, camps and hospitals, balloon sheds and airplane hangars, not to mention the installation of water, heating, lighting, and sanitary systems. And, bear in mind, the oversea

activities of the Engineers were not confined to France, but extended to England, Italy, Russia, and Siberia.

"*Essayons!*" The more I have seen of the work of the Engineers, the more appropriate seems their motto.

"*Essayons!*" There is apparently nothing that these men with the castles on their collars will not essay. And everything they essay they accomplish.

III

THE GAS-MAKERS

WERE you to grow up with a boy who eventually became widely talked about, watching him pass from knickerbockers to trousers and from youthful shyness to burly aggressiveness, the chances are that you would follow his career with an almost proprietary interest, and that when you came upon his picture in *The World's Work* or *The Police Gazette*, according to whether he had become famous or notorious, you would display it to your friends, explaining proudly: "Why, I've known him ever since he was a youngster. I always felt sure that he would attract attention some day."

Such, in a manner of speaking, has been my acquaintance with poison-gas, or toxic-gas, as the chemists call it. I was in the Ypres salient, on the British front, when the first gas attack in the history of warfare was launched against the Africans and Canadians on April 22, 1915, and that night, in the hospitals, I saw the earliest victims of gas warfare, gasping on their cots like fish thrown on the bank to die. On several occasions during the months which followed I again encountered the malign creature—on the Yser, in the Champagne, in Alsace, and on the Isonzo—and on each succeeding occasion it was more threatening and was causing greater concern. So that when, after the United States had been at war a year or more, I visited the great arsenal at Edgewood,

on the shores of Chesapeake Bay, and was shown the vast plants devoted to the production of chlorine, chlorpicrin, phosgene, mustard, and other deadly gases, and caught the familiar nauseous odor, I felt as though I were renewing an old and undesirable acquaintance.

I doubt if the Germans started the war with the intention of utilizing poison-gas, for they did not introduce it until nine months after the beginning of hostilities, and even then they apparently failed to realize the terrible potency of their new weapon, for they waited twenty-four hours before following it up with a bayonet attack, evidently fearful that the gas had not dissipated. As a matter of fact, the gas dissipated within thirty-five or forty minutes after its release, though in that time it annihilated 80 per cent of the French, Canadians, and Senegalese opposing it. Had the Germans taken instant and vigorous advantage of the confusion and dismay created by their unexpected use of chlorine, they could unquestionably have broken the Allied front, pushed through to the Channel ports, and changed the entire course of the war. (I might mention, parenthetically, that the British had been warned by a deserter, a week before, that the Germans were making preparations for a gas attack, but they did not believe him.) But the men in the spiked helmets failed to take advantage of the Allies' temporary panic; the latter had time to improvise a means of defense, and the opportunity of the Germans to win the war by the use of gas was gone. So effectively, indeed, did the Allies turn the new weapon to

their own uses that, before the close of 1916, the Germans were putting out feelers for the purpose of bringing about a cessation of this form of warfare. Then the United States entered the war, whereupon all the resources of American laboratories and chemical manufactories were directed toward the production of gas in quantities of which the Germans had never dreamed.

But, even had the Allies been aware of Germany's intention to make use of toxic-gases for military purposes, they would still have been at an enormous disadvantage, because, as a direct result of her policy of giving government assistance to certain industries, Germany had several huge gas-plants, connected with her dye manufactories, in operation when the war began. Now phosgene, which is comparatively easy to produce, is used extensively in the manufacture of dyes, which explains why the Germans had a virtual monopoly of it when they decided to utilize it for the promotion of dying instead of dyeing. The German Government, it should be remembered, had for years subsidized the entire chemical industry of the empire, so that when the war began it had at its disposal scores of establishments devoted to the production of dyestuffs and pharmaceutical preparations, in the production of which certain toxic-gases are an important factor, which were converted, literally overnight, to military purposes. Though there is no data regarding the German gas production available, it was probably in the neighborhood of 30 tons a day. It may have reached 50 tons, but certainly not more. Though the English, realizing how desperate was the situation,

utilized every facility they could command, their total daily output of toxic-gases never went above 30 tons. The best the French could do was much below this. Yet at Edgewood, during the months of September and October, 1918, when the plant had been in operation only a few months, the output averaged 140 tons a day and would have gone much higher had the war continued. In other words, *Edgewood Arsenal alone produced nearly twice as much gas per day as Germany, France, and England together.*

Now I wish to lay special emphasis on the fact that when the United States decided to manufacture gas, and to manufacture it in hitherto undreamed-of quantities, we were embarking on strange and uncharted seas. We manufactured almost everything else under the sun, but of the production of these toxic-gases we knew little save in theory, because virtually their only commercial value was in the making of certain dyes and chemicals, for which we had depended almost wholly on Germany. It was a new game which we had to learn—and to learn quickly. We found ourselves in the position of a baseball-player who is unexpectedly called upon to bowl in a game of cricket on which the championship depends. But when word went out from Washington that chemists were needed to beat the Germans at their own game, the masters of the retort and the test-tube left their classrooms and closed their laboratories and from every corner of the republic came flocking to the colors. I am using no mere figure of speech when I assert that the mammoth gas industry which was built up from nothing

in less than a twelvemonth, knowledge of which was without question largely contributory to breaking down the German morale, was the work of American college professors. Some one, an Englishman, if I remember rightly, once referred to Germany as "the land of damned professors." When their batteries and battalions were sent reeling back by American-made gas, the Germans must have felt like applying the same term to the United States.

Notwithstanding the remarkable standard of efficiency which it ultimately attained, the Chemical Warfare Service, or the Gas Service, as it was originally called, passed through a checkered and stormy formative period. By the close of 1917, when we had already been at war for nine months, there was hardly a branch of the American Army which did not have a finger in the affairs of gas warfare. The manufacture of masks was under the direction of the Medical Corps. Gas and shell production was in the hands of the Ordnance Department. Alarm devices were produced by the Signal Corps. The gas and flame troops formed the 30th Regiment of Engineers. Field-training was directed by the Sanitary Corps. Research work, an extremely important phase, was carried out by the Bureau of Mines, a branch of the Department of the Interior. And, to complete the decentralization, arrangements were being made to form a chemical service section of the National Army for the purpose of conducting gas operations overseas.

There is nothing to be gained by describing the long series of misunderstandings, controversies, and

recriminations which constituted the history of gas warfare during the early months of 1918. It is not pleasant reading. It is enough to say that the demoralization resulting from this divided authority, taken in conjunction with the introduction by the Germans of mustard and other new gases, and the difficulty which the English were experiencing in obtaining a sufficient supply of chlorine, brought about a situation which caused grave alarm to all who were familiar with the situation in Europe. The two chief obstacles in the way of a complete reorganization of the service were the Ordnance Department, the chief of which was unwilling to permit all of the gas activities of Ordnance to be controlled by an external authority, and the Bureau of Mines, which refused to permit its chemists and its organization to be absorbed by the War Department. Though at that time it was impossible to modify the attitude of the Bureau of Mines in regard to its control of research, the Chief of Ordnance did his best to improve conditions within his own department by placing Colonel William H. Walker, assistant director of the Gas Service and former professor of chemical engineering at the Massachusetts Institute of Technology, in complete control of gas production, including the operation of the great plant at Edgewood, the branch factories throughout the country, and the experimental field at Lakehurst, New Jersey. The manner in which this college professor brought order out of chaos at Edgewood and its related plants, directed the activities of 7,000 soldiers and 8,000 civilian workmen, settled labor troubles,

obtained material, completed and put into operation the largest toxic-gas plant in existence, and, by his insistence on manufacturing at Edgewood all types of gases, including a large proportion of the basic chlorine, made the government independent of manufacturers and contractors, was one of the most remarkable accomplishments of the war.

In May, 1918, Major-General William L. Sibert, Corps of Engineers, who had commanded the First Division in France, was appointed by the President as director of the Gas Service for the express purpose of reorganizing that service and placing it on a footing commensurate with the importance it was now realized to have. General Sibert promptly took the position that, if he was to assume this responsibility, there could be no further divided control; all gas production and all research work must be in his hands. Ensued then lengthy discussions between the War Department and the Department of the Interior, enlivened by newspaper articles and speeches in Congress, as to whether the research chemists of the Bureau of Mines should pass under military control, but General Sibert's attitude remained unshaken and, on July 13, 1918, all branches of the work connected with gas warfare were placed under his control as chief of the Chemical Warfare Service, henceforward a complete and separate branch of the army.

When the United States entered the war, none of the toxic-gases used by the warring nations, with the exception of chlorine, had been prepared in this country except on a very small scale and as laboratory ex-

periments. The War Department was faced, therefore, with the immediate problem, not only of developing methods for the manufacture of these gases on a large scale, but also of putting these methods into execution. Gases, the preparation of which even in very small quantities was prohibited in many laboratories on account of their highly dangerous character and which, for the same reason, the Railroad Administration refused to transport except by special trains, were now to be produced by the thousands of tons. But how? There was no suitable machinery for the purpose to be had in the United States; everything must be designed and built to order. And where were the thousands of workmen who would be required to come from? Why should a man exchange the safety of a shipyard, where he was getting undreamed-of wages, for the perils of making poison-gas? It was indeed a stupendous problem which the government was facing. Yet there was no time to mull the question over, as a judge mulls over a point of law, for every day brought word of an increasing use of gas by the Germans.

It was the original intention to interest existing chemical firms in the manufacture of the required gases, with the hope of obtaining from them the entire supply required. As the project developed, however, difficulties arose which prevented the carrying out of this programme. The director-general of railroads ruled, as I have just said, that the gases could only be transported by special train movement, and this would entail great difficulty, delay, and expense. More serious objections were encountered, however, in the

efforts to enlist the co-operation of the chemical manufacturers. The methods for the production of toxic-gases on a large scale were quite unknown, the manufacturers explained, and to discover and develop satisfactory processes would necessarily require extended investigations. The companies also realized that there would be great danger to the lives of those employed in the work, that fatalities were almost certain to result, and they were unwilling to run the risk of the interminable lawsuits which are usually incidental to the settlement of such cases. Moreover, only a limited number of firms had the personnel and the experience necessary to undertake the difficult problems involved, and these firms were already crowded with war work and were unwilling to assume additional responsibility, particularly of such a character. And, finally, it was recognized that the manufacture of toxic-gases would be limited to the duration of the war, and that the processes involved, as well as the plants necessary for carrying out these processes, would have little value after the war was over.

Meanwhile the Ordnance Department had approved of a plan to utilize a portion of a tract comprising 35,000 acres, near Aberdeen, Maryland, on Chesapeake Bay, which had just been acquired by the government for a proving-ground, for erecting a suitable plant for filling shell with poison-gas—though at that time it had not been determined where the gas itself was to come from. As soon as it became evident that the necessary quantities of gas could not be obtained from private firms, the War Department decided to erect

and operate its own gas-plants on a peninsula of the Aberdeen Reservation, known as Gunpowder Neck. This peninsula, consisting of about 3,500 acres, which was admirably suited for the purpose by reason of its remoteness from centres of population, its security, and its facilities for rail and water transportation, was named Edgewood Arsenal.

Only those who saw the low-lying, swamp-lined shores of Gunpowder Neck during the winter and spring of 1917–1918 can fully picture the obstacles with which our gas-makers were confronted. Have you ever seen a Virginia road after the spring rains? Yes? Imagine, then, this Virginian clay mixed with Mexican adobe and diluted with New Orleans molasses and you will have a slight idea of the nature of the soil over which enormous quantities of material had to be hauled and on which was erected the greatest manufactory of poison-gas in the world. It may be recalled, moreover, that the winter of 1917–1918 was the severest in the memory of the oldest inhabitant. For weeks on end the shores of the Chesapeake resembled the shores of Greenland, but, in spite of cold and mud and rain, in spite of apparently insurmountable difficulties in obtaining building materials and in securing transportation for those materials on the congested railways, in spite of strikes and labor troubles of every kind, the work forged steadily ahead, officers and men working themselves as a negro teamster works his mules. Scores of miles of roads were built and metalled, a network of railways was laid down, and over them snorted panting locomotives hauling endless caravans of freight-cars.

The building sites were illuminated by hundreds of arc-lights, the working force was divided into shifts, and the reservation resounded both night and day to the creak of derricks, the clatter of riveters, and the rasp of saws. A total of 558 buildings were constructed on the grounds of the arsenal, including, in addition to the huge structures of steel and concrete which comprised the filling and the various chemical plants, 36 cantonments with quarters for 8,400 men, 3 field-hospitals, a base hospital with more than 400 beds, bunk-houses for civilian workmen, officers' barracks, Y. M. C. A. and Knights of Columbus huts, and one of the most completely equipped laboratories in the country. Edgewood is, in reality, a collection of great manufacturing plants, with all that implies in housing, sanitation, heating, storage, hospitalization, and other agencies. And the work was done by men every one of whom, from the commanding officer down, was in civil life when the war began. Not a single officer or man of the Regular Army had any responsibility for the construction or operation of Edgewood Arsenal from the day that the ex-professor of chemistry, Colonel Walker, assumed command, until its operations were terminated by the Armistice.

Any one who has had practical experience in manufacturing well knows that it is usually a long step from laboratory experimentation to factory production, a step which it often takes months and sometimes years to make and which is frequently beset with all manner of difficulties and problems. But there was no such time at the disposal of the Edge-

wood gas-makers. In all their experiments they were never permitted to slack up on production. The need was too vital. Our armies in France were clamoring for gas, gas, gas. There were no existing models for much of the machinery needed, but the corps of brilliant young men with whom Colonel Walker had surrounded himself invented as they went along. Yet, as a result of the experiments at Edgewood, numerous new and more economical processes were discovered. The slow and dangerous water-cooling method of producing phosgene, as followed in Europe, was supplanted by an entirely new system and a plant was perfected which could turn out forty tons of this gas every twenty-four hours. When the Edgewood plant was put into operation the government was paying one dollar and fifty cents a pound for phosgene, but when the Armistice was signed we were manufacturing it at the theretofore unheard-of price of ten cents per pound and would have brought it to an even lower figure had the production been continued. The systems devised for filling, painting, and marking the shell were marvels of mechanical ingenuity. These discoveries were not intended for commerce. They were the result of patriotic effort on the part of the workmen to see the nation excel in the particular thing in which it was then engaged—war. They were the outgrowth of impatience over slow and dangerous methods, or a desire to do the work in hand a little better or a little more quickly than it had been done before—a quality inherent in the American character.

It is a remarkable commentary on the efficiency

of the Edgewood organization that notwithstanding the fact that the manufacture of poison-gases in quantity was a new industry in the United States, that the machinery was improvised or designed from the ground up, that the workmen were without previous experience—many of the drafted men, mind you, were fresh from offices, stores, and farms—and that they were engaged in a peculiarly hazardous occupation, only four fatalities were directly traceable to poisoning by gas. This should not be construed as minimizing the peril attached to the work, however, for, though every possible precaution was observed in the construction and operation of the plants, there were 925 casualties between June and December, 1918, of which 674 were due to mustard-gas. During the month of August, when the gases were most volatile as a result of the excessive heat (during that month the mercury stood at 106 degrees for three days in succession), and when the weather caused the soldiers to somewhat relax their precautions, the hospitals were on several days filled at the rate of 3½ per cent of the entire force of the mustard-gas plant, though this rate of casualties was not maintained, of course, throughout the entire month. I might add that several of the divisions which took part in the St. Mihiel offensive sustained a considerably smaller percentage of losses, which shows that the dangers of the war were not entirely monopolized by the men who served in France.

Long before the chemical plants were completed it became evident that civilian labor could not be utilized in their operation. Not only was such labor difficult

to obtain, but the wages were abnormally high, the work was, as a whole, extremely inefficient, and it was virtually impossible to maintain the discipline and secrecy imperative to the success of the undertaking. Moreover, it was found that such civilian labor as was available could not be depended upon to work in the chemical plants because of the danger attending the manufacture of such highly poisonous materials. It was decided, therefore, to utilize enlisted men. As the project progressed, increasing numbers of soldiers from the National Army were detailed to the arsenal, the force reaching a strength of 7,400 at one time. The soldiers, no matter how much they disliked the work, could not quit like the civilian laborers; they had no option but to obey orders, and so, morning after morning, they rose at the summons of the bugles in the dim light of early dawn, hurried through their breakfasts at the long tables in the mess-halls, and marched to their respective tasks, whether making chlorine, chlorpicrin, phosgene, or mustard gas, filling or painting shell, working in the great refrigerating-plants through which the shell were passed to be chilled before filling, loading trains and boats, building roads, digging ditches, or firing boilers—all for thirty dollars a month. To the men who wore the blue-and-yellow hat-cords of the Chemical Warfare Service, the men who performed their dangerous work without advertisement and without public recognition, is due the gratitude of the nation.

The chief activities of the great arsenal on the Chesapeake consisted, as I believe I have already men-

tioned, of the manufacture of four types of toxic-gas—chlorine, chlorpicrin, phosgene, and mustard—and the filling of shell with these gases. Now I have not the slightest intention of entering upon a technical account of the complicated processes by which these gases were produced. Though no doubt interesting to chemists, it would make dry reading for others. It will suffice for the purposes of this book to sketch in briefest outline, and in simple words, the chief characteristics of the principal toxic-gases and the methods followed in their manufacture.

Chlorine, which is the first gas the Germans used and which is an important constituent of nearly all the other toxic-gases, is derived from ordinary table-salt. It is prepared by passing a current of electricity through a solution of salt, by which process chlorine is liberated and caustic soda formed. At ordinary temperatures chlorine is a greenish-yellow gas of strong, suffocating odor, but by means of cold and pressure it can be readily condensed to a liquid and is usually shipped in that form, stored in strong cylinders. The apparatus in which the salt is decomposed by the electric current is known as a cell. The salt, upon arrival at the arsenal, was taken to the brine building and dumped into large concrete tanks kept partially filled with water, the resulting brine being drawn off, purified, and pumped to the cell-house as needed. The interior of this building was filled with cells, nearly 4,000 in all, through which was passed a direct current of approximately 260 volts. The chlorine thus extracted from the brine was liquefied by compressing it through the

agency of a falling column of sulphuric acid and then cooling the compressed gas by refrigeration. Though chlorine has long been manufactured in the United States for chemical purposes, a constant supply of it was so essential for the preparation of the other gases that Colonel Walker insisted that it should be produced at Edgewood, thus making the government independent of private manufacturers.

Chlorpicrin, while not so poisonous as some of the other gases, is, nevertheless, an active poison and has, in addition, pronounced lachrymal (tear-producing) and nauseating qualities. Though chlorpicrin is fatal when taken in large quantities, it is almost impossible to inhale much of it because of its terribly nauseating effect. The inhalation of four cubic inches of it causes violent vomiting. Chlorpicrin is produced by the action of picric acid upon chlorine in the form of bleaching-powder. The bleaching-powder, after being diluted with water to the consistency of thick cream, is mixed with a solution of calcium picrate in large stills holding 5,000 or more gallons. A jet of live steam is introduced at the bottom of the still and the reaction begins at once, the resulting chlorpicrin passing out of the still into condensers. This mixture of chlorpicrin and water is then run into tanks. As chlorpicrin does not dissolve in water, it gradually settles to the bottom and is drawn off and loaded directly into the shell.

Phosgene, the next member of the poison-gas family, is the deadliest of the lung-gases, killing almost as quickly as cyanogen. It is produced by the

combination of two other gases, chlorine and carbon monoxide. The reaction is effected in iron boxes, lined with lead and filled with charcoal, into which a stream of chlorine and carbon monoxide, mixed in proper proportion, is introduced. The colorless gas which results is phosgene. It is condensed to a liquid by passing it through a condenser surrounded by brine kept cold by refrigeration and is then either stored in strong steel containers or run directly into the thirty-pound cylinders known as Livens' drums. These drums are fired from a sort of mortar, called a projector, and are extremely effective for producing heavy concentrations of gas up to a range of 1,500 yards.

The compound commonly referred to in chemical warfare as "mustard-gas" is known to chemists as dichlorethylsulphide. Its nature is as formidable as its name. It has a distinctive smell, like garlic rather than mustard. It has no immediate effect on the eyes, beyond a slight irritation, but after several hours the eyes begin to swell and inflame and practically blister, causing the most intense pain; the nose discharges freely, and severe coughing and even vomiting ensue. Direct contact with the spray causes blistering of the skin so severe that it is virtually burned. Even when protected by masks and specially made clothing, it is impossible for troops to remain for more than eight hours in an area which has been bombarded with mustard-gas. Dichlorethylsulphide, to use its correct name, is produced by blowing ethylene-gas into liquid sulphur monochloride in large iron reaction vessels. Contrary to the popular impression, this gas contains

no mustard. The details of devices and methods for introducing the ethylene and sulphur monochloride into the vessels, the removal of the product, the necessary agitation and cooling of the mass, and the like, were frequently changed during the development of the process and had not reached a final form even when the Armistice was signed. Nevertheless, when the war ended, Edgewood was producing 30 tons of mustard-gas a day and a rapid increase up to 100 tons daily was practically assured.

Though the Germans began their use of gas by releasing it from cylinders, depending upon the wind to carry it over the enemy's lines, these "cloud attacks," as they were called, did not prove satisfactory and were eventually discontinued, for great difficulty was experienced in getting the heavy cylinders up to the front and installing them in the trenches, and favorable winds could not be depended upon. It seems likely, indeed, that the Germans failed to recognize the significance of the meteorological records and charts of northern France, which show that 75 per cent of the prevailing winds are from a southerly or southeasterly direction, thus leaving the Germans only 25 per cent of the time in which they could use their gas without danger of its being blown back over their own lines. It was in order to overcome these meteorological conditions that the Germans evolved the idea of loading the gas into shell, usually in the form of liquid, which turned into gas when it came into contact with the air upon the explosion of the shell, and firing these shell from guns or mortars, thus enabling them to place the gas wherever

they desired without reference to the weather. During the last two years of the war, barring a few isolated instances, gas was used in no other way.

The filling of shell was, therefore, one of the most important of Edgewood's many activities. Let me explain to you, as simply and briefly as possible, how the shell were filled with phosgene.

The empty shell, after inspection, were loaded on trucks together with the required number of loaded boosters. (A booster, it should be explained, is the cap or stopper containing a charge of high explosive, usually T N T or dynamite, which is screwed on the nose of the shell after it has been filled with gas, much as a metal top is screwed onto a bottle. Just before firing, a fuse is inserted in the booster, igniting the explosive, which in turn shatters the shell, thus releasing the gas.) The trucks with the empty shell were then run by electric locomotives to the filling buildings. Here the shell were transferred to a conveyer, a sort of moving platform, which slowly moved through a room kept cold by refrigeration. About thirty minutes was required for this operation, during which time the shell were cooled to a temperature of about zero. This chilling of the shell was made necessary because phosgene has a low boiling-point. It was imperative, therefore, that the temperature of the shell be kept considerably below the boiling-point of phosgene in order that the latter should remain in liquid form while the filling was taking place. The chilled shell were then transferred to trucks and hauled by motor through the filling-tunnel to the filling-machines. Here the phosgene, kept

in liquid state by refrigeration, was run into the shell by automatic machines. The truck then carried the filled shell forward a few feet, at which point the boosters were screwed into the noses of the shell by hand. The final closing of the shell was then effected by motors operated by compressed air. The filled shell were next conveyed to the shell-dump, where they were classified and stored for twenty-four hours, nose down on skids, in order to test them for leaks. The following day the shell were again placed on conveyers which carried them through a painting-machine, where air-brushes gave them a coat of elephant gray and striped them with the distinctive bands of color which denoted the type of gas they contained. The methods followed in filling shell with chlorpicrin were similar to those for phosgene except that refrigeration was unnecessary. The peculiar properties of mustard-gas, however, required an entirely different filling system. Edgewood Arsenal also had separate plants for filling the stannic-chloride hand-grenades used for "mopping up" trenches; for filling both shell and grenades with white phosphorus for use in forming smoke-screens to conceal the movements of advancing troops, and for loading the incendiary drop-bombs used by the Air Service.

The various plants which I have just described by no means comprised the whole of Edgewood's activities, however, for, in order to obtain a sufficient supply of bromine, certain compounds of which are excellent tear-producing materials, a series of brine-wells was sunk at Midland, Michigan; a plant for the production

of another lachrymator, brombenzyl cyanide, was erected at Kingsport, Tennessee; and an establishment for the manufacture of diphenychlorarsine—an arsenical material used in gas warfare because it produces violent sneezing, thus causing the troops to remove their gas-masks and thereby exposing them to the effects of the toxic-gases used in combination with the arsenicals—was started at Croyland, Pennsylvania.

As a matter of fact, the great mother-plant on Chesapeake Bay had branches and ramifications of which the public had scarcely an inkling, so carefully were the details of our gas production guarded. I have already pointed out that it was the original intention to secure the entire supply of toxic materials from existing chemical plants, and that it was only after this plan was found to be unfeasible that the decision to build government plants was reached. This decision did not signify, however, that no such material would be obtained from existing firms. On the contrary, it was decided to utilize such firms whenever it was possible to secure their co-operation. But as the products desired had never been prepared on a commercial scale in this country, it was impossible to forecast with accuracy the cost of their manufacture. As a result, the co-operation of the existing chemical concerns could be secured only on the condition that the government would finance the work. These plants, therefore, though they continued to be operated by their owners, became in fact government plants, being financed by the government, representatives of the

War Department being stationed at each establishment to supervise their administration and look after the government's interests. At first they were under the direction of the trench warfare section of the Ordnance Department, but, under a later order, they were made a part of Edgewood Arsenal and placed under the administration of its commanding officer. The list of these outside plants, with their official designation and the product manufactured in each, is as follows:

Edgewood Arsenal, Niagara Falls Plant: Manufacture of phosgene.

Edgewood Arsenal, Midland (Mich.) Plant: Sinking of brine-wells for the purpose of securing adequate supplies of bromine.

Edgewood Arsenal, Buffalo Plant: Manufacture of mustard-gas.

Edgewood Arsenal, Bound Brook (N. J.) Plant: Manufacture of phosgene.

In addition to the above, the following outside plants were not only built (or were in process of construction at the date of the Armistice) but were operated as well by the government. Their location at points other than Edgewood was decided upon partly because of the fact that it was thought wise to have at least two plants for the manufacture of each important material located at different places, since an accident at one would in no way interfere with production at the other. These government-owned establishments were:

Edgewood Arsenal, Stamford (Conn.) Plant: Manufacture of chlorpicrin.

Edgewood Arsenal, Hastings (N. Y.) Plant: Manufacture of mustard-gas.

Edgewood Arsenal, Kingsport (Tenn.) Plant: Manufacture of brombenzyl cyanide.

Edgewood Arsenal, Croyland (Pa.) Plant: Manufacture of diphenychlorarsine.

In addition to these nine great outlying plants, with their thousands of workmen, there was the splendidly equipped Research Department at American University, on the outskirts of Washington; the Experimental Field and Proving-Ground near Lakehurst, New Jersey; and the Army Gas Schools at Camp Kendrick, New Jersey, and Camp A. A. Humphreys, Virginia.

The tract of land near Lakehurst taken over for experimental purposes was 5 miles long and 4 wide and had an area of nearly 14,000 acres. As the nearest habitation was 2½ miles away no difficulty was experienced in conducting the highly important experiments with the necessary secrecy. The camp included quarters for 50 officers and barracks for 800 men, a completely equipped chemical laboratory, the staff of which included expert glass-blowers who could make every kind of apparatus required, a meteorological station, commanded by a former official of the Government Weather Bureau, equipped with the latest apparatus necessary for making and recording meteorological observations, a mechanical shop containing lathes, drills, and tools for making repairs of every

description, an ice-making plant, a post hospital, a goat hospital, a dog hospital, a dog kitchen, and enclosures for animals which had to be kept under observation for long periods. In order to determine the effects of the various gases on living subjects a large stock of animals—goats, dogs, cats, rats, mice, guinea-pigs, and monkeys—had to be kept constantly on hand. These animals were not obtainable in the necessary numbers without considerable difficulty, it being necessary, on one occasion, to send an officer to Mexico to purchase 1,500 Angora goats, experiments having shown that the goat possesses powers of resistance to gas which more nearly approximate those of a human being than does any other common animal. Representatives of these various animal types were placed in trenches modelled after those on the Western Front and bombarded with different forms of gas-shell, those which remained alive being subjected to close observation, sometimes for many days, by the experts of the Pathological and Physiological Department. A human note enters into this grim business of preparing for war in the fact that those animals, particularly the dogs, which survived such an experiment were not subjected to it again. I imagine, however, that the officials of the S. P. C. A. would have entered a vigorous protest had they been permitted to lift the veil of secrecy which for many months enveloped the operations of the Chemical Warfare Service at Lakehurst.

The new methods and devices in gas warfare which were developed by the great corps of scientists and

laboratory experts attached to the American University Experiment Station were given practical trials at Lakehurst, where they were tested under conditions approximating as nearly as possible those of actual warfare. Here experiments were carried out to determine the value of gas-shells bursting in the air instead of by impact, the value of mixing toxic or lachrymatory gas with shrapnel, the value of 14-inch naval shell filled with a combination of high explosive and toxic substance, and the value of clouds of poison-smoke. Had the war continued, I imagine that the results of some of these experiments would have given the Germans the surprise of their lives.

Though the gas production of Edgewood Arsenal from August to November, 1918, increased from 450 to 675 tons a week, and though the filling-plant had a weekly capacity of nearly 1,000 tons, less than 100 tons of gas was actually filled into shell weekly. This unfortunate state of affairs was due to the failure of the Ordnance Department to supply enough, or nearly enough, shell and boosters to keep pace with the production of gas. In other words, there was far more gas than there were shell to put it in, and far more shell than there were boosters for them. During the early summer of 1918, large quantities of this surplus gas were shipped overseas and there loaded into shell, but later instructions were received to stop all shipments in bulk except a limited amount of chlorine. From that time on, the production of gas was limited by the number of shell and booster available, because it is impossible to store toxic-gases in any large quan-

tities. In fact, at all times after the manufacture of poison-gases began in the United States, the supply of such materials was not only in excess of the supply of shell and booster, but the gas-plants could not be operated to their full capacity because there was no way of utilizing the maximum output.

Do you remember how often, during the months immediately following our entrance into the great conflict, one heard the assertion made that American inventive genius would eventually produce a weapon so dreadful, so potent, that it would end the war because flesh and blood would be unable to withstand it? It was asserted, with a wealth of circumstantial detail, that Mr. Edison had been locked up for weeks in his New Jersey laboratory perfecting a device for the wholesale slaughter of the Huns which would startle the world. But, as the war continued on its bloody course, the public faith in inventors gradually waned and the American people settled down to a realization that victory could be achieved only by man-power, munitions, and food. Yet the persons who talked so glibly of some startling discovery which would paralyze the efforts of the enemy and abruptly end the war little realized how near to the truth their imaginations led them—*for the government actually had in its possession the secret of a weapon so terrible that, had it been used, it would probably have ended the war.*

The story of how the secret came into the possession of the government is a curious one. Years ago a student of chemistry, then living in a foreign country, while carrying on a series of laboratory experi-

ments, stumbled upon a chemical combination which almost cost him his life. It was a compound never before made, or, at least, never recorded. Later the chemist came to the United States, but it was not until he read of the use of toxic-gases by the Germans that he recalled his all but fatal experiment of many years before. He kept silence, however, until America's entry into the war, when he imparted his formula to the government. The chemist's assertions of what his compound could accomplish were at first received with considerable scepticism, but this scepticism abruptly disappeared when the reports from the Research Division of the Chemical Warfare Service at American University, where the formula was developed, were received. So appalling was its nature, indeed, that the War Department at first refused to permit the use of the weapon thus strangely placed in its hand on the ground that the nation using it would be guilty of inhumanity. But in July, 1918, following the wholesale use of mustard-gas against our troops by the Germans, the scruples of those in power disappeared and orders were given that quantity production of the new toxic material should immediately be begun.

This super-gas, as it has been termed, was known to the Chemical Warfare Service as G–34, though it was more commonly referred to as methyl, a name which was given it because it in no way suggested the true character of this newest and deadliest of poisons. It has also been dubbed "Lewisite" because it was developed from the original formula to a stage which made it practicable for military use by Professor W.

Lee Lewis, chief of the Defense Department of the Research Division of the Chemical Warfare Service. Methyl, or Lewisite, is an oily, amber-colored liquid, with an odor which vaguely suggests that of the geranium. It is somewhat more volatile than mustard-gas, being comparable in that respect to benzol. Instead of being inoffensive at first contact, like mustard, it starts an acute pain which quickly becomes unendurable. A single drop spilled on the hand will penetrate to the blood, attacking first the kidneys, then the heart and lungs. It hardens the cell-tissues of the lungs and causes simultaneously strangulation and a weakening of the heart which result in speedy and violent death. If taken into the lungs by inhalation in any perceptible quantity it kills almost instantly, the victim dying in terrible agony. *It is estimated to be seventy-two times deadlier than mustard-gas.*

The manufacture of methyl was carried on in an abandoned motor-car plant at Willoughby, Ohio, a suburb of Cleveland, the work being in charge of Colonel F. M. Dorsey, who, before the war, was a chemical engineer in the employ of the General Electric Company. Every step in the process of manufacture was enveloped in the most profound secrecy. Every workman who entered the stockade surrounding the plant did so under a voluntary agreement not to leave the eleven-acre space until the war was won, though this arrangement was later modified upon the men promising upon their honor not to divulge the nature of the product or even the existence of the plant.

All mail was censored and even the use of the word Willoughby in correspondence was forbidden, letters for the officers and men connected with the plant being addressed to a lock-box in Cleveland. There was no recreation, the work was hard and danger was always present, the men working with their gas-masks constantly at the "alert" position. Though none of the masks designed for protection against chlorpicrin, phosgene, or mustard were of the slightest avail against methyl, the safety of the workers was ensured by specially designed masks and clothing. Had we used methyl against the Germans, however, it is extremely unlikely that they would have succeeded in devising a means of protection against it—at least in time to save themselves.

The methyl, as manufactured, was loaded into both shell and drums. The shell, of 155mm. calibre, contained about ten pounds of the liquid, which becomes a gas upon contact with the air; the drums, which held from 350 to 400 pounds each, were to be dropped from airplanes. It is estimated that half a hundred of these drums, judiciously distributed, would exterminate the entire population of Manhattan Island. When the Armistice was signed methyl was being produced at the rate of approximately ten tons a day and the plant at Willoughby was two months ahead of its schedule, orders having been given that 3,000 tons should be in France, ready for use, by March 1, 1919. It was well for Germany that she quit when she did. Had methyl been turned loose against the Huns, civilization would have had its revenge on the

assassins of the *Lusitania*, on the fiends who ravaged France and raped Belgium.

Within forty-eight hours after the signing of the Armistice the work of dismantling the plant at Willoughby had begun, and ten weeks later its demolition was complete. A special train, running at night under heavy guard, carried the hundreds of tons of methyl which had already been produced, in iron containers, to Edgewood Arsenal, where it was transferred to a steamer, taken out to sea, and lowered into three miles of salt water. But the formulæ and processes for manufacture still exist, locked away in the great vaults of the War College in Washington, so, if the nation is ever again forced to take up arms, it has at hand the most terrible weapon ever devised for the purpose of wholesale slaughter.

Notwithstanding the fact that toxic-gases had been in almost constant use by the European belligerents for two years before the United States entered the conflict, the declaration of war found us totally unprepared to commence the manufacture of the gas-defense equipment with which every soldier going overseas must be provided. Such an article as a gas-mask had never been produced in this country, the sum total of American knowledge on the subject having been obtained from the masks brought back as souvenirs by war correspondents and displayed in shop-windows and from the pictures in the illustrated papers. Incredible as it may seem, in view of the enormously important rôle which gas was playing on the European battle-fields, only a single American army

officer, Major L. P. Williamson of the Medical Corps, had studied the subject of gas defense, and he had done so on his own initiative. Thus it came about that within a few days after the declaration of war, the military authorities, confronted by the imperative necessity of providing our expeditionary forces with gas-defense equipment, were conducting a frantic search among the various scientific departments of the government to discover one possessing the necessary facilities for handling the problem. The Bureau of Chemistry did not have the personnel to carry on the work and the Department of Agriculture did not have the necessary apparatus, but the Bureau of Mines at Pittsburg possessed some experience in kindred problems arising from mine-rescue work, and it also had adequate facilities for handling the experimental work involved. It was, therefore, selected for the purpose. The research facilities at Pittsburg soon proved inadequate, however, and in the summer of 1917 there was taken over the American University Experiment Station, near Washington, where virtually all of the research work connected with the numerous branches of the Chemical Warfare Service was conducted. The Research Division, instead of being dismissed with passing mention, is deserving of a chapter to itself, the services which it performed in the development of gases, protective equipment, and manufacturing processes having been of enormous assistance in the prosecution of the war.

When, in May, 1917, the need arose for providing masks for the first contingent of the American Expedi-

tionary Forces, the War Department appealed to the Bureau of Mines to provide 25,000 masks within three weeks. Emboldened by the valor of ignorance, the officials of the bureau jauntily undertook the task, making arrangements for the fabric to be produced by a rubber company at Akron, Ohio, and for the masks to be assembled at a factory in Brooklyn. Instead of producing 25,000 masks in three weeks, however, the best they could do was to produce 20,000 in two months. These were immediately shipped overseas. But the rubberized fabric of which they were made was easily penetrated by chlorpicrin vapor, therefore affording very little protection, and they were returned unused. "The only thing about them which is satisfactory," General Pershing is said to have remarked, "is the strap around the neck." But the experience thus gained opened the eyes of the authorities to the gravity of the problem, so that when, in July, 1917, the army itself took up the manufacture of gas-masks, it was with a more complete realization of the magnitude of the task by which it was confronted. One of the first steps taken by the War Department, upon assuming charge of mask production, was to give a colonel's commission to Mr. Bradley Dewey, an officer of the American Can Company, and to place him in command of the Gas Defense Service, as it was then called, but which, upon the organization of the Chemical Warfare Service, became the Gas Defense Division. Thanks to the energy, resourcefulness, and business ability of Colonel Dewey, backed by the efficiency and enthusiasm of the great organization which he

MAN AND HORSE COMPLETELY PROTECTED AGAINST POISONOUS GAS.

In addition to the mask, the man is wearing an anti-mustard gas suit, gloves, and boots. The horse is provided with boots and a gas mask.

TYPES OF GAS MASKS USED BY AMERICAN AND EUROPEAN ARMIES.

U. S. Navy Mask (obsolete). U. S. Navy Mask. U. S. C. E. Respirator. U. S. R. F. H. Respirator. U. S. H. T. Respirator. U. S. H. T. Respirator. U. S. Model 1919 Respirator.

British Black Veil Mask. British P. H. Helmet. British Box Respirator. French M. 2 Mask. French Tissot Art. Mask. French A. R. S. Mask.

German Late-type Mask. Russian Mask. Italian Mask. British Motor-Corps Mask. U. S. Rear Area Emergency Respirator. U. S. Connell Mask.

created, the American forces in France were protected against gas by masks which, as proved by actual field tests, *gave twenty times the protection afforded by those worn by the Germans.*

It is essential that a mask, or respirator, to use its correct name, should remove all traces of gas or smoke from the air before it reaches the eyes, nose, or mouth of the wearer. The principal features of the mask of the "Box Respirator" type, as used by the American forces throughout the war were:

(*a*) A canister of metal containing both neutralizing and absorptive chemicals and a smoke filter. The air to be breathed passes in through an inlet check valve and through chemicals and smoke filter.

(*b*) A flexible rubber-hose through which the purified air passes from the canister to the face-piece.

(*c*) A face-piece, effectively covering the eyes, cheeks, lower forehead, nose, mouth, and chin, provided with eye-pieces permitting vision and a harness to hold the face-piece in place.

(*d*) An exhalation valve which affords easy discharge of exhaled air and at the same time instantly closes upon inspiration.

(*e*) A knapsack slung from the neck or shoulder, in which the mask and canister are carried.

In the box respirator type, the inhaled air, passing through the canister and hose, went directly into the mouth through a rubber mouth-piece, which in this manner offered protection to the lungs in the event of the face-piece being damaged or not fitting. The mask was also provided with a spring and rubber clamp

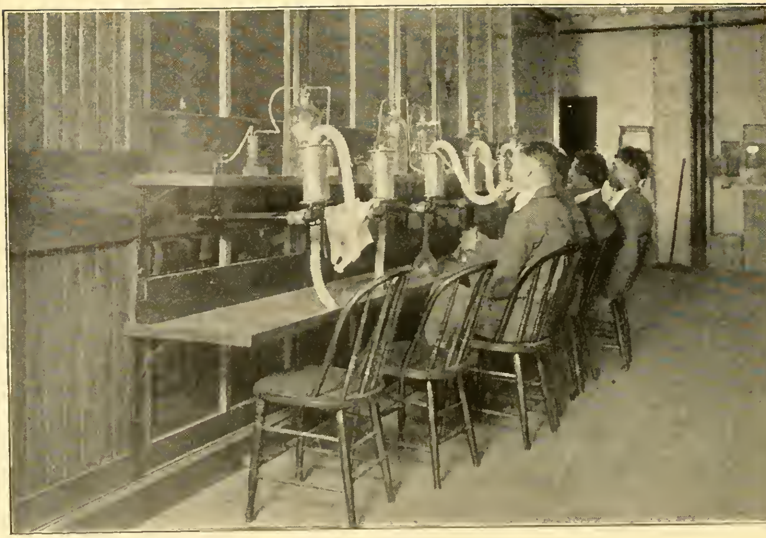
which closed the nostrils and compelled the wearer to breathe entirely through the mouth.

While the box respirator was in process of manufacture, much thought and effort was devoted to developing a mask which would combine with its safety and good vision a greater measure of comfort, it being particularly desired to eliminate the nose-clip and the mouth-piece, which are the box respirator's most uncomfortable features. The starting-point in these attempts was the French Tissot mask, several modifications of which were put into production. The best mask of this type was designed, curiously enough, by a New York corset manufacturer, Major Waldemar Kops, whose name was given to his invention, which is known as the K.T. or Kops-Tissot mask. One hundred and eighty-nine thousand of the K.T. masks, which were radically different and far more comfortable than the box respirator type, had been manufactured when the Armistice was signed. The total number of masks produced by the Gas Defense Division was more than three and a half million.

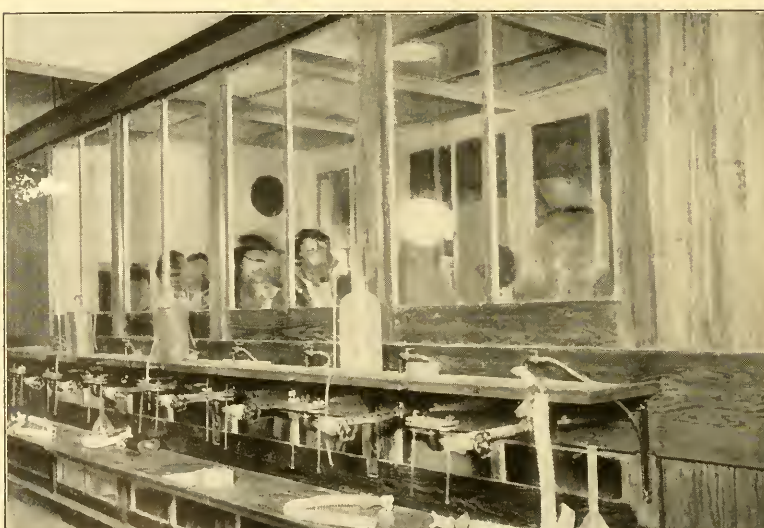
The mask-makers were confronted at an early period with the problem of finding a charcoal of sufficient density to absorb the toxic fumes, the wood-charcoal which was used in most of the French and British masks being very far from satisfactory. After considerable experimentation it was discovered that a charcoal having sufficient absorptivity could be produced from the shell of the cocoanut, whereupon officers were despatched to the Hawaiian Islands and the British West Indies to arrange for large shipments

1,500 TONS OF PEACH-PITS USED FOR THE MANUFACTURE OF CHARCOAL FOR USE IN GAS MASKS.

The result of the appeal of the Gas Defense Division for nutshells and fruit-pits.



TESTING RESPIRATORS OUTSIDE THE GAS CHAMBER.



TESTING GAS MASKS INSIDE THE GAS CHAMBER.

of cocoanut-shells to the United States. The supply thus obtained proved entirely inadequate, however, whereupon the Chemical Warfare Service issued an appeal to the American public to save the shells of Brazil nuts, hickory-nuts, and walnuts, the pits of peaches, prunes, apricots, and cherries, and the seeds of dates, the collection of the pits and shells being undertaken by the Red Cross, the Boy Scouts, and kindred organizations. Placards and receptacles were put in public places throughout the country and almost immediately fruit-pits began to pour in by the ton, every family making it a point of honor to save its pits "for the boys fighting overseas," as they proudly put it. There were numberless cases of old ladies who sent in by mail a few peach-pits which they had conscientiously saved and which they had cleaned as carefully as though they were jewels. As it required 7 pounds of pits and shells to make the charcoal for a single mask, 3,500 tons were used in the million masks which we sent overseas.

Because it was realized that the slightest flaw or imperfection in a finished mask might well mean the death in agony of an American soldier, an extremely rigid system of inspection was devised. It was discovered, for example, that all thread holes must be filled with gelatine, in order to prevent the gas from being carried through by the thread; that wrinkles in the band around the face and head permitted gas to leak inside the face-piece; that the mouth-piece must be reinforced with bushings so that the soldier would not bite it in the excitement of a gas attack and there-

by cut off his own breath. Only the most painstaking and conscientious women—usually those having husbands or sons at the front—were chosen for the work of final inspection, and, even after they had examined each mask in every detail it was again inspected over a bright light in a dark booth for small pinholes which might have escaped the ordinary visual inspection. And, in order to make the inspectors doubly careful, they were frequently required to go into the gas-chambers wearing masks chosen at random from those they themselves had passed. To obtain absolute results as to the protection afforded by a mask, however, breathing tests in a gas-chamber had to be employed. This testing was done by enlisted men of the Gas Defense Division, who spent many hours each day testing masks and canisters in the gas-chambers, sometimes working in a concentration of phosgene as high as 1 per cent. Without hope of glory or promotion, without the lure of decorations, these men day after day, month after month, risked their lives in order that their fellows at the front might have a better chance to live. Though they wore silver instead of gold chevrons, they are as deserving of thanks and admiration as the men who broke the Hindenburg line or battled in the Forest of the Argonne.

Though the earlier gas-masks were manufactured in Brooklyn, and later in Philadelphia, the operations of the division expanded so rapidly that by November, 1917, it became evident that it was no longer practicable for a commercial organization to carry on the manufacture of this new and vitally important article

of equipment in the quantities demanded by the new army programme, and it was consequently deemed advisable to establish a government-owned and controlled organization. In pursuance of this policy, the work of mask manufacture was transferred in November to Long Island City, the plant expanding in seven months from a floor space of 157,000 square feet to 1,000,000 square feet, or 23 acres. When the Armistice was signed the Gas Defense Division had a personnel of 274 officers, 2,353 enlisted men, and 13,000 civilians. Much of the work was done by women, and, as a traitor could have worked irreparable damage by tampering with the masks, the employees were selected only after the closest investigation by the Military Intelligence Division of their antecedents and affiliations. From the very outset the officers in charge of mask production conducted a campaign for efficiency based on patriotism. The walls of the factory were hung with copies of a poster depicting a soldier dying from gas as the result of a defective mask; it bore the grim and suggestive title "The Last Inspection." Lectures and motion-pictures were used to emphasize the horrors of death by gas. And everywhere were placards bearing the admonition: "Remember that *your* carelessness may cost the life of *your* husband, *your* son, *your* brother."

It is not generally appreciated, I think, that gas warfare has tactics all its own. For example: In preparing for an infantry attack the Germans were accustomed to first concentrate all their guns on our

batteries. After a brief but intensive bombardment of our artillery positions a portion of the German batteries would abruptly switch their fire onto our infantry, using, of course, a large proportion of gas-shell. Meanwhile the German infantry officers had been notified as to the kinds of gas their batteries were using, and where. Hence, when the German storming troops swept forward they did not wear masks, for their officers knew that a non-persistent gas had been used against the point which was to be attacked. Our troops, being ignorant of this, however, had donned their masks when the first gas-shell came over, and were, therefore, both fatigued and hampered when they were called upon to resist the assault.

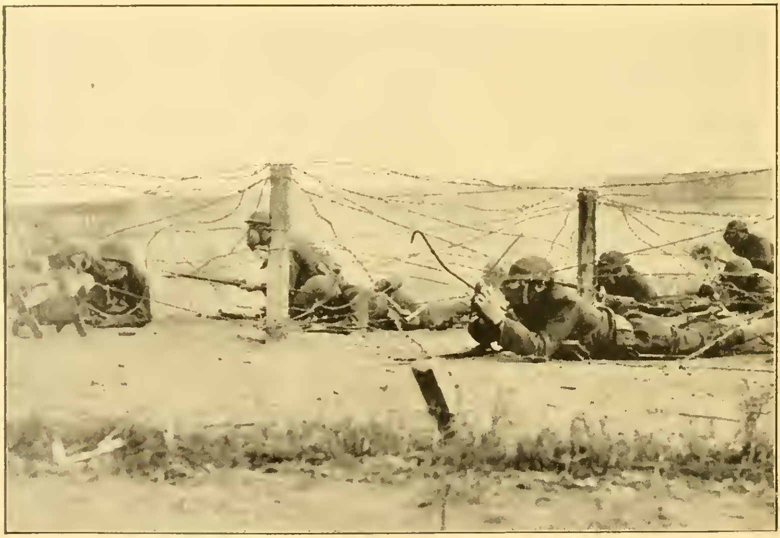
And here is another example of gas tactics: Word having reached the French that the Germans were planning to attack a certain sector near Rheims, the troops holding this portion of the line were quietly withdrawn from the front trenches the night before the attack was to take place, a few autoriflemen being left to simulate a defense. Before the troops departed, however, they placed mustard-gas shells, which had been fitted by the artillery with electrically controlled fuses, in the dugouts. The French gunners had, meanwhile, ascertained to a foot the range of the trenches which were being evacuated. At daybreak came the expected German attack. As the helmeted figures came swarming across No Man's Land in the dim light of early dawn the few remaining Frenchmen set off green rockets as a signal to the artillery and took to their heels. No sooner had the Germans oc-

ADVANCING UNDER GAS.

This photograph was not taken in real action but at the Army Gas School in France.

TRAINING FOR GAS WARFARE.

Troops wearing gas masks charging in open order in practice at Long Island City.



CUTTING THEIR WAY THROUGH BARBED-WIRE ENTANGLEMENTS WHILE TRAINING WITH GAS MASKS.

cupied the evacuated trenches, therefore, than the French batteries turned loose on them a hurricane of steel, putting down a barrage which completely cut them off from their own lines. The Germans naturally sought shelter from this shell-storm in the deserted dugouts. At about the same moment a French artillery officer pressed his finger upon a button, an electric current leaped along a buried wire, the shells in the dugouts were blown asunder, liberating the poison-gas—and the Germans perished almost to a man.

As the result of the experiments at American University, Lakehurst, and Edgewood, and the experiences of our troops in the field, several new gases of incredible deadliness were invented as well as numerous new methods of using them, many of which would certainly have been utilized had the war continued. But the League of Nations being still confined to paper, and universal disarmament being still in the distant future, it is as well, I feel, not to particularize about them. It is enough to say that, thanks to the work of the Chemical Warfare Service, there are stored away in the vaults of the War Department certain plans and formulas which, in the event of another war—which God forbid! —would give us a weapon of undreamed-of potency and terror. Speaking from first-hand knowledge, I can assure any potential enemies of the United States that the chemical warfare which we are prepared to wage should the necessity ever arise again would make our recent gas activities, vast as they were, seem like a joke.

IV

THE "Q. M. C."

SOME years ago there was exhibited at the Grand Salon in Paris an immense mural painting, intended, if I remember rightly, for one of the walls of the Panthéon. I think it was by Détaille, but of that I am not certain nor does it matter. The canvas, which reached from floor to ceiling, was of such vast dimensions that the gallery, huge as it is, did not permit of a satisfactory perspective; it was characterized, moreover, by such a wealth of detail that one might look at it from dawn to dusk and yet not grasp it all. So in attempting to depict, even in the sketchiest fashion, the operations and activities of the Quartermaster Corps, I find myself embarrassed by the same limitations. The composition is too vast for proper perspective, too rich in variety and detail to be grasped by the imagination. The best that I can hope to do, therefore, in the limited space at my disposal, is to hurry you along, like the guides who used to conduct visitors through the galleries of the Vatican in an hour, pointing out a picturesque feature here and calling your attention to something of interest there—touching only on the high spots, as it were.

To begin with, let me give you some conception of the subject's magnitude and importance. The total cost of the war to the United States, plus the estimate of the amount which would be required to carry it on to July 1, 1919, was approximately $16,500,000,000,

while the total expenditures and estimates of the Quartermaster Corps for the same period were something over $8,500,000,000. Thus it will be seen that *the expenditures and requirements of the Quartermaster Corps comprised more than half of the total expenditures and requirements of the entire army.* The purchases which it made were remarkable not only for their unprecedented volume but for their amazing variety. It supplied the armies of the United States with practically everything they required, save only ordnance, its purchases running all the way from coal to needles, from lemon-drops to rolling kitchens, from sheet-music to beef and mutton on the hoof. At one time it constituted the entire wool trade of the United States, if not, indeed, of the whole Western Hemisphere, for it optioned every pound of wool in sight and sent its agents out with orders to buy up the excess wool of the earth. It purchased enough cotton goods to make a sheet which would cover the District of Columbia four times over. It controlled the leather trade of the nation. It operated the largest shirt-factory in existence. It developed the most highly specialized shoe ever made, purchased 33,000,000 pairs of them, carried them in 120 sizes, and opened schools to teach its officers the science of shoe-fitting. By enlisting the co-operation of a score of universities it established a great correspondence school for the education of quartermaster officers. It had other schools, a whole system of them, where training was given in cooking, baking, butchery, and coffee-roasting. It purchased every stock of rubber boots and rain-coats in the United

States. It established and operated farms and truck-gardens at the various camps and cantonments. By organizing a Salvage Service for the reclamation of articles which would otherwise have been thrown away it saved 151,000,000 of the taxpayers' dollars. The army needed horses and mules—thousands and thousands of them—whereupon the Quartermaster Corps gave commissions to half a hundred of America's best-known sportsmen and gentlemen riders and sent them to the West, to Spain, to the Argentine, to purchase animals. General Pershing cabled that he wanted sheet-music for the 390 bands of the A. E. F., whereupon the Quartermaster Corps, not being itself musically inclined, looked about for a man who was. It was discovered that the most successful composer of popular music in America had enlisted in the Coast Guard, but the Quartermaster Corps borrowed him, told him to select the sort of music that he thought the boys in France would like, and send it to Pershing. He did. It cheered up the army overseas and cost the government $50,000. It was cheap at the price. The Quartermaster Corps educated manufacturers in the production of articles strange to their experience, and in some cases it developed entirely new industries. It was a shipmaster, a wool-grower, a coal-operator, a clothier, a builder of vehicles, a school-teacher, a reformer of labor conditions, an inventor of new products, and an originator of new methods. To the miners of Pennsylvania, quarrying coal in the low-roofed galleries by the light of their flickering lamps, to the fruit-pickers in the sun-drenched orchards of Hood River

and the Santa Clara, to the pallid clothing-workers, bending over their machines in the stifling sweat-shops of the New York Ghetto, to the great manufacturers of New England, and to the beef barons of the Middle West, "Quartermaster Corps, United States Amry," was a phrase to conjure with.

In those casual, comfortable, easy-going days before the Great War startled us out of our national complacency, when the work of the army consisted in garrisoning many small and widely scattered posts and in doing police duty on the Canal Zone or in "the Islands," the Quartermaster Corps, the "Q. M.," as it was familiarly called, occupied much the same relation to our little military establishment that a "general store" does to a village. By this I mean that it supplied most of the army's wants. It was charged, to put it briefly, with clothing, feeding, housing, and paying the army, supplying it with horses, harness, vehicles, and, in short, virtually everything else save only the actual tools of war. It also manned and operated the steamers of the Army Transport Service, was charged with the movement of troops on land, and had jurisdiction to a large extent over motor transportation, especially the movement of supplies. Though its business methods were as antiquated as the quill pen and the copying-press, like the mules which drew its wagons it jogged unconcernedly along. If the colonel's wife needed some shelves in her kitchen she sent for the quartermaster and they were put up with neatness and despatch. When the junior officers at a post

wanted to attend a dance in town the quartermaster could always be depended upon to provide a conveyance. The quartermaster ran the post exchanges and canteens. If there was a delay in the delivery of the winter's coal, if the bread was poorly baked, if the milk was sour, if the men's shoes did not fit, if there was a leak in a barracks roof, if a horse developed a spavin, if the pay-checks were not received on time, it was the quartermaster who had to take the blame. He was all things to all men, and if he did not do all things as well as they might have been done, it was not his fault so much as the fault of the antiquated and cumbersome system in which he had been trained.

But upon the outbreak of war this state of affairs underwent a sudden change. It was no more possible for the Quartermaster Corps, as it was then organized, to feed and clothe and transport overseas an army of 5,000,000 men than it would be for a village merchant to meet the demands which would be made upon him if oil were discovered in the vicinity and the village expanded into a city overnight. At the outbreak of the war the Office of the Quartermaster-General consisted of five divisions—Administrative, Finance, Supplies, Construction, and Transportation—but when our stupendous military programme began to assume definite form it became increasingly apparent that no single department could successfully direct so many and varied activities, and that the Quartermaster Corps must confine itself to the huge task of purchase and supply. The first step toward its reorganization along these lines was the divorce of the Construction Divi-

sion, which was made a separate branch of the War Department under Colonel (later Brigadier-General) I. W. Littell, who reported directly to the secretary of war. Though the officers of this division, to which was assigned the tremendous task of constructing the camps and cantonments for our new armies, continued to wear the insignia of the Quartermaster Corps, and though they were known as construction quartermasters, they had no connection with the Office of the Quartermaster-General. During the first year of the war the Transportation Division operated a considerable fleet of vessels engaged in the transport of troops, animals, and supplies, but in April, 1918, this division was abolished, the entire transportation service being taken from the Quartermaster Corps and placed with the Purchase, Storage, and Traffic Division of the General Staff. The next branch to be lopped off was the Finance Division, the functions of which were transferred to the newly organized Office of the Director of Finance, who assumed charge of all financial matters for the army. In response to the constantly increasing demands for motor transport, a Motor Transport Service was added to the Quartermaster Corps in April, 1918, but was taken away from it three months later and established as a separate branch of the army under the title of the Motor Transport Corps. This is, however, strictly an operating unit and should not be confused with the Motor and Vehicles Division of the Quartermaster Corps. By this time the "Q. M." had been so completely transformed as to be almost unrecognizable

to men who had grown old in the service. Little remained of the old organization, indeed, save the name, and even that all but disappeared when, in October, 1918, the Office of the Quartermaster-General was merged in the newly organized Office of the Director of Purchase and Storage. By the concluding month of the war, therefore, the old Quartermaster Corps had lost all control over construction, finance, and transportation, so that of its original five divisions only the Administrative and Supplies remained. The latter had been expanded, however, into nine purchasing divisions and there had also been added to the organization—now commonly referred to as "Purchase and Storage"—five storage divisions and a Salvage Division. At the same time that the Office of the Director of Purchase and Storage assumed the functions of the Quartermaster Corps it also took over the procurement activities of the Medical Corps and of the Corps of Engineers, as well as procuring certain standardized articles for the Signal Corps and the Ordnance Department, thus bringing under a single head all the purchase, storage, and distribution agencies of the army. In order to make this extremely involved relationship a little clearer, I ought to explain, perhaps, that the Office of the Director of Purchase and Storage is one of the three chief operating branches of the Purchase, Storage, and Traffic Division of the General Staff, the others being the Office of the Director of Traffic and the Office of the Director of Finance.

In the old days the procurement activities of the army were decentralized to such an extent that every

depot, camp, and post, wherever situated, had charge of procuring practically everything it used except uniforms, the procurement being under the direction of the camp or post quartermaster, as the case might be. The new organization has produced a system, however, whereby everything required by the army is purchased either by the officers in charge of the thirteen General Supply Zones into which the United States has been divided, or direct from Washington. It is scarcely necessary to comment on the enormous saving in time, money, and labor thus effected. We will now say "Amen" to this little sermon on organization, which is a dry subject at best, and turn to more interesting topics.

Of the countless problems which confronted the Quartermaster Corps at the outbreak of the war, by far the most important was that of feeding the army, for an army, as Napoleon inelegantly but truthfully put it, travels upon its belly. The American soldier, like the American small boy, is a prodigious eater and he is always hungry. He is, moreover, extremely finical about the quality and variety of his food. He has been accustomed from boyhood to have unrestricted access to the cooky jar and the cake-box, and things were wrong, indeed, when there were not at least three kinds of mother's pies on the top shelf in the pantry. He laughed at danger and jeered at hardships, but in return he expected a grateful Uncle Sam, as represented by the Quartermaster Corps, to show the same consideration for him when it came to a question of

food that his mother had always done. And Uncle Sam measured up to his expectations. Not only was the American soldier given all the food that he required —at the time of the Armistice approximately 10,000,000 pounds of food were being sent every day to the troops in France—but he had the best food in Europe. In those lean days of 1918, when it was impossible to obtain a spoonful of sugar in the smartest restaurants in Paris, and when the manufacture of pastries of every description had been prohibited by law, the Yankee doughboys always had full sugar-bowls and unlimited quantities of pies, cake, and puddings. Indeed, it is not the slightest exaggeration to say that the American enlisted man had a considerably better mess than most French generals. I know, for I have eaten with both.

Never before has an army been called upon to send subsistence so great a distance to so many men. It was obviously impossible to ask France and England to provide for our rapidly increasing armies from their own scanty stores, for those countries were already rationing their civilian populations. The food had, therefore, to be obtained in the United States, some of it being transported 6,000 miles before reaching the mess-tables of the A. E. F. Moreover, in order to provide against the possibility of the food-ships being torpedoed or the capture of the base depots, it was necessary to send two pounds of food where one would ordinarily have answered. To make things worse, as the demands for food increased, the available tonnage decreased. The utmost economy in space became so imperative, indeed, that inspectors from the Packing

Service Branch were stationed at the various depots with instructions to pay particular attention to the thickness of lumber used in the packing-cases and to insist on the utilization of every cubic foot of spare space, as, for example, the boilers in rolling kitchens, which were filled with various articles of subsistence supplies. Even the marmites—the camp cooking-pots—were filled with beans, peas, and other dry stores. When, in the spring of 1918, the Germans launched that tremendous offensive which has been so fittingly called "the charge of a nation," and every available ton of shipping was required for the transport of the troops which we were rushing overseas to stem the Teutonic onslaught, all canned fruits and vegetables—pears, apples, pineapple, peas, corn, asparagus, sweet potatoes—were stricken from the lists, such space as was available being filled with boneless beef, dried fruits, dehydrated vegetables—and tomatoes! I do not mean to imply that such mainstays as the "four B's"—bread, bacon, beef, and beans—were sacrificed for the juicy fruit of the tomato-vine, for they were not, but tomatoes were regarded as such an important item of the soldier's menu that, notwithstanding the poverty of space, their shipments, instead of being diminished, were increased. In addition to the customary ways of serving them, thousands of cans were taken up to the line to relieve the soldier's thirst, a quart of tomato juice being more effective than a gallon of water. Lest you should get the impression, from what I have just said, that there was a shortage of beans, I might mention, in passing, that 75,000,000

cans of baked beans with tomato sauce were put in the hands of the army cooks, and in order to provide against any possible lack of this stand-by, there was purchased to supplement them 77,000,000 pounds of dried beans. I have never heard an American soldier complain that he did not have enough beans. Foreseeing the enormous demand which there would be for prunes and dried apricots and apples, the quartermaster-general summoned from his ranch in the Santa Clara Valley of California, where he was living in pleasant retirement, the foremost authority on dried fruits in America, informed him of the army's needs, and gave him *carte blanche* to fill them. He sent overseas enough prunes to have supplied all the boarding-houses in America for years to come. Coffee was another important item. The British Army consumed enormous quantities of tea, the Italians depended largely upon their cheap native wines, and the French drank an alleged coffee which was really camouflaged chicory, but the American troops were given real coffee —the best that money could buy. Nothing better illustrates the quality of the food served to our men than the following telegram, sent by the quartermaster-general of the A. E. F. to Washington.

"Ship 2,000,000 reserve rations packed in hermetically sealed galvanized iron cases, 25 to the case, meat to be substituted in lieu of bacon and choice George Washington coffee or other similar substitute in lieu of ground coffee."

As even the best grades of coffee can be ruined if improperly prepared, there were established at Camp

Meade and Camp Johnston schools for coffee-roasting. Here enlisted men were given a course of instruction in coffee roasting, blending, grinding, and packing, and upon graduation were sent to the various camps where coffee-roasting plants had been installed. Thus the soldier received a fresher and a better cup of coffee than ever before, and the government made a saving of from two to three cents a pound, for as the green coffee was shipped to the camps by the various Zone Supply officers and was roasted every day, there was practically no overhead expense incurred.

Beef is, of course, the chief muscle and fat-producing food, the army allowing 456 pounds of beef per year for each soldier. This does not mean, however, that the soldier actually eats that amount of beef annually, for, just as the currency of the country is based on the gold standard, the meat ration of the army is based on the beef standard. It is customary, therefore, to substitute pork, usually in the form of bacon, for 30 per cent of the beef ration, twelve ounces of bacon being equivalent to twenty ounces of beef. The balance of the meat ration consists for the most part of fresh beef, when it is procurable, supplemented by canned beef, corned beef, and canned hash. The meat-cutting for the army is performed by Butchery Companies, the personnel of which was trained at Camp Joseph E. Johnston, near Jacksonville, Florida, where a practical course of instruction was given in cutting meat by the so-called "natural-guide method." By following this method, which is an expanding rather than a cutting process, inexperienced men who did not

know a cleaver from a skewer were made into practical meat-cutters in less than two months. The curriculum of the School for Butchers also included a course of intensive training in the boxing of boneless frozen beef by a method which saved about 32 per cent storage and cargo space and was used extensively during the winter months. With the return of peace, graduates of this unique educational institution, many of them illiterate, find themselves as well qualified to take up the butcher's trade as though they had wielded a cleaver and worn a white apron all their lives.

In spite of all that has been written by travellers and novelists about certain American delicacies—the ham of Virginia, the chicken of Maryland, the pies and doughnuts of New England, the pompano of New Orleans—the fact remains that Americans, as a people, are not good cooks. This assertion may be ridiculed by some of my readers, but, generally speaking, it is true. Almost any Frenchman can prepare from the cheapest materials a well-cooked and tempting meal; the ability of most Americans in the culinary art is confined to boiling eggs. A man who spends his days in an office can sit down to a breakfast consisting of soggy biscuits, poorly prepared coffee, and an omelet that looks and tastes as though it were made of chrome leather, and though it may affect his disposition it will not seriously affect his work, for when the noon-hour comes around he can go over to Delmonico's or step into Childs's, as his tastes and pocketbook may dictate, and restore his balance of digestion by a well-cooked meal. But the soldier had no such resource.

There were no Delmonicos or Childses at the front. He had to eat what was given him. And as his vigor and staying powers depended on his food, it was essential that that food should be well cooked. To tell the truth, the Italian débâcle of 1917 was due as much to poor and insufficient food as it was to Austrian propaganda, for nothing affects morale like an empty stomach.

When war was declared the Regular Army and the National Guard already had, of course, their complements of experienced cooks and bakers, though in wholly insufficient numbers, but the huge National Army had nothing of the sort. One of the earliest and most pressing problems of the Quartermaster Corps, therefore, was to train sufficient numbers of men for this work, which it did by expanding the fourteen Cooks' and Bakers' Schools of the regular establishment to twenty and by starting new schools at the various National Army cantonments. Before these schools could be successfully operated, however, it was necessary to obtain an adequate staff of instructors, who themselves had to be trained, the plan being to give at least one officer in each regiment or separate battalion sufficient training to make him competent to conduct a school for cooks and bakers in his own organization. As a result of this system of culinary education, within a year after the first American troops set foot in France the Quartermaster Corps had trained 1,200 instructors in cooking, 16,000 mess sergeants, and 50,000 cooks, in addition to which there were 40,000 others who, though they had not received sufficient training to give them

a cook's rating, were nevertheless entirely competent to prepare food. From the soldiers thus trained there were organized about seven-score Bakery Companies, more than half of which saw service overseas. Now that these hundred-odd thousand cooks and bakers have returned to civil life, there is reason to hope that there will be manifested a striking improvement in the quality of the national cooking. It may be that, as a result of this war-enforced training, we will be able to look forward to taking a meal in a railway restaurant or in a small-town hotel without dread and, perhaps, even with pleasure.

The food for the troops in cantonments, camps, and rest billets was, of course, prepared in permanent camp-kitchens, which usually possessed all the facilities and sometimes a far greater serving capacity than the kitchens of great hotels. As the front was approached, however, the problem of preparing food became increasingly difficult, particularly in the areas which were being systematically harassed by the enemy's artillery and airplanes. To have erected kitchens in such areas would have been to invite their destruction. In order to provide hot food for soldiers occupying these exposed positions, as well as for troops on the march, recourse was had to rolling kitchens—*les cuisines roulantes*, as the French called them. Each kitchen, which was drawn either by a mule-team or by a tractor, consisted of a stove and limber. The stove contained a bake-oven and three kettles, thus permitting of four kinds of food being prepared simultaneously. The limber, which was a two-wheeled cart to which

the kitchen was attached, was fitted with four bread-boxes which could also be used for water, a cook's chest containing a set of culinary utensils which would make a housewife envious, four kettles, and four fireless cookers. The fireless cooker was, I think, first used for military purposes on the Italian Front; at least that was where I first saw it. It was an invaluable contrivance, as it permitted food to be prepared many hours in advance in the back areas and yet served piping hot to the men on the firing-line.

For use under heavy fire or other conditions which made it impossible to serve the men with hot food from the rolling kitchens, the trench ration, consisting of tinned meat, hard bread, and soluble coffee, together with salt and sugar, was designed. The food was packed in hermetically sealed, gas-proof, camouflaged iron containers, each of which held twenty-five rations, each ration in turn consisting of enough food to maintain a soldier for one day, sustaining his full strength and vigor. The food used in the trench ration was the very best that money could buy. Indeed, it became a matter of pride with the employees of the great plants where the trench rations were prepared to use exceptional care in selecting the ingredients for them, for it was realized what good food meant to the tired and mud-caked men who were holding the Frontier of Freedom. The office force of one of the big packing-houses learned from a shipping-clerk that the interstices between the tins in the packing-cases were being filled with excelsior, so they took up a collection, to which every one from presi-

dent to office-boy contributed, and used the money to fill those interstices with tobacco and cigarettes. When the officers of the Subsistence Division heard of this they thought so well of the idea that orders were issued that the empty space in all trench-ration containers should be filled with tobacco thereafter. Scores of such incidents, trivial enough in themselves, showed how the hearts and thoughts of the nation were with the boys who were fighting overseas.

Every American soldier when he went into action carried in the upper left-hand pocket of his blouse a small flat tin—no larger than the pocket Bible which the sob-story writers always place in that same pocket to stop the fatal bullet—bearing on its lid the legend: "U. S. Army Emergency Ration. Not to be opened except by order of an officer, or in extremity." This was the American equivalent of the "starvation ration" of the European armies. To it many a man caught in a shell-hole between the lines or lost in the Forest of the Argonne owed his life. Its contents represented the results of many experiments and much experience and the combined suggestions of scientists, food experts, and soldiers. The emergency ration consists of three rather dubious-looking cakes of prepared beef combined with a bread compound made of ground cooked wheat, weighing three ounces each, three ounces of chocolate, three-quarters of an ounce of fine salt, and a dram of black pepper. There are almost as many ways of preparing the ration as there are of preparing an egg. The bread-and-meat cakes can be eaten dry—provided one is sufficiently near starva-

tion. When boiled in three pints of water they make a palatable soup, and when the water was obtained, as was frequently the case, from shell-holes and ditches, the pepper and salt served to disguise the muddy flavor. Where water was scarce, only a pint of it was needed to transform the cake into a sort of porridge, something like cornmeal mush, which could be eaten hot or cold or which could be sliced and fried, circumstances and the Germans permitting. The chocolate could be made into a drink by dissolving it in hot water, or it could be eaten as candy.

Candy, by the way, formed one of the most acceptable items of the American soldier's ration, half a pound being issued to each man every ten days. In December, 1918, the Subsistence Division shipped to the A. E. F. more than 10,000,000 pounds of candy—the largest exportation of its kind on record. Don't get the idea that this was "grocer's candy"—the kind that comes in wooden buckets. It was nothing of the sort. No society girl, sitting in a box at a matinée, munched better chocolates than the American soldier. Moreover, the same chocolates which sold for a dollar a pound in the candy-stores of America could be bought for forty-eight cents a pound in the canteens of the A. E. F. Stick-candy and lemon-drops which ordinarily sold for seventy cents a pound at home were sold to the soldiers for twenty-eight cents. I say *sold*, for the pound and a half of candy which was a part of every soldier's ration rarely satisfied the sweet tooth of the doughboy. Though everything in the confectionery line from peppermints to caramels

was provided, lemon-drops were the soldier's favorite. They were to the Yankee doughboy what gum-drops were to Doctor Cook's Esquimaux. They devoured them at the rate of a hundred tons a month! At the beginning of the war it was found that most of the lemon-drops manufactured for the commercial market, being made of glucose and inferior or imitation fruit flavors, were not of good enough quality for the soldiers. So lemon-drops of the most expensive kind—the kind that they sell in the smart shops on Fifth Avenue and Tremont Street and Michigan Boulevard—were adopted as a standard, the recipes for making them being distributed to a number of candy manufacturers. Now the lemon-drops for the army are made from pure granulated sugar and flavored with an emulsion made from the rind of the lemon. The sourer they are the better, say the soldiers. So great became the demand for candy—which, by the way, is of great value in rebuilding wasted tissues—that the Chief Quartermaster of the A. E. F. took over a number of French candy factories and, using American sugar, manufactured huge quantities of candy for our troops in France.

Tobacco was a recognized item in the ration of the A. E. F., statistics showing that 95 per cent of the men used it in one form or another—which serves to show how the soldier vote would go should the reformers ever attempt to saddle the Constitution with an antitobacco amendment. To men enduring great physical hardships, obliged to live without the comforts and frequently without the necessities of life, and always under the terrific strain imposed by war,

tobacco fills a need which nothing else can satisfy. In view of this, it was decided to adopt the practice of our allies and allow each soldier a certain amount of tobacco a day, the ration being four cigarettes, four ounces of chewing-tobacco, or four ounces of smoking-tobacco, and one hundred papers. Though cigars were not included in the army ration, they could be purchased at the Quartermaster stores in France at astonishingly low prices. Havana cigars were sold at the same price which the government paid for them in Cuba, there being no tax or import duty, no charge for transportation, and no middleman's profit. Smokers of cigars will appreciate how cheap they were when I mention that at the commissaries in France I paid eighteen cents apiece for Corona Coronas. In order to provide "smokes" for the army, the entire stocks of several of the largest cigarette and tobacco manufacturers were commandeered—a fact with which they quickly acquainted the public in their advertising. A single purchase consisted of 3,000,000,000 cigarettes—enough to provide two "fags" for approximately every human being on the globe. The difference between the old army and the new was strikingly illustrated by the difference in their choice of tobacco. The soldier of the old army was most strongly addicted to the use of that unlovely article known as "plug"—thereby giving steady employment to the spittoon-makers. The men of our new armies, however, expressed an overwhelming preference for the cigarette. Thus does tobacco gauge the progress of civilization!

A close third to tobacco and candy in the affections

of the soldiers was chewing-gum. Three and a half million packages of the shop-girl's delight were sent overseas during the month of January alone. Chewing-gum has come, indeed, to be regarded as little short of a necessity for the soldier, both because of its value as a substitute for water—it is estimated that 250 pounds of chewing-gum will save 100 gallons of water when it is needed most—and because it is a heat and energy producer. During intensive drilling, practice firing, and on marches the more gum a man chews the less water he drinks—obviously a highly important consideration, for at the front water is usually scarce and difficult to obtain. Curiously enough, the consumption of gum is heavier in winter than in summer, this doubtless being due, as I have already mentioned, to the fact that it is a heat-producer. It took the British, oddly enough, to devise a novel and interesting use for chewing-gum which was later adopted by certain of our own commanders. Just before an attack, when the assaulting battalions were formed up on the tapes waiting for the word which would send them over the top, the enemy's scouts, prowling in No Man's Land, frequently detected the presence of the waiting troops by their subdued chorus of coughing. A British officer who had been in the United States evolved the idea of stopping these betraying coughs by giving every man a stick of chewing-gum. So Messrs. Wrigley, Beeman, White, and Adams may congratulate themselves on having "done their bit" toward walloping the Hun.

My mention of a chorus of coughs naturally sug-

gests the subject of music, which was another of the multitudinous activities of the Quartermaster Corps. By this I do not mean to imply that the "Q. M." furnished the army with bands, for it did not, but it did supply the bands of the army with instruments and music. Music, you must understand, was one of the most important factors in the maintenance of that intangible something called morale. It was a curious characteristic of the American psychology that when a homesick soldier heard a band playing "Home, Sweet Home," or "When You Come Back," or "Keep the Home Fires Burning," it did not increase his homesickness. It had, instead, precisely the opposite effect: it cheered him up! Recognizing this, the military authorities saw to it that bands were stationed in every town and hamlet in France where any considerable body of troops was billeted. By the last summer of the war we had in France nearly 400 bands, to say nothing of the musical organizations improvised by the various units. As a result, the French inhabitants of the zones in which our armies were operating became as familiar with "Over There," "Good Morning, Mr. Zip-zip-zip," and particularly with "Oh, How I Hate to Get Up in the Morning," which was the soldier's favorite because it so satisfyingly expressed his feelings, as they were with the "Marseillaise." The American Army was, indeed, as noticeable for its musical proclivities as the French Army was for its total absence of them. Ours was a whistling, singing army, if ever there was one, though for some reason it seemed to delight in plaintive, melancholy tunes.

Many and many a time I have heard a column coming down a road in the darkness, the softly whistled chorus of "The Long, Long Trail" rising above the clink of accoutrements and the *slog-slog-slog* of marching feet.

In the early summer of 1918 the Quartermaster-General received a cable from General Pershing requesting that $50,000 worth of sheet-music for the bands of the A. E. F. be shipped without delay. As the chief of the purchasing unit, to whom the order was turned over, did not feel qualified to select the music for some 3,000,000 of his fighting countrymen, he delegated the task to a committee consisting of Lieutenant R. C. Deming, bandmaster at Camp Meigs, Mr. Ward Stephens, the noted organist and authority on music, and Irving Berlin, the most famous composer of popular music in America, who was at that time a sergeant in the Coast Guard but who was borrowed from that organization by the Quartermaster Corps. The selection and classification of this great mass of music—the largest single order of its kind ever given—necessitated the committee working almost night and day for weeks, it being enormously assisted in its task by the enthusiastic co-operation of the various music printers and publishers, both of these trades making great financial sacrifices in order to promote the pleasure and inspiration of the boys overseas.

Have you ever gone into one of those huge emporiums which make a specialty of supplying equipment for sportsmen, to purchase an outfit preparatory to a fishing-trip in Canada or a shooting expedition in the

Rockies? If so, you will remember how much time and thought you devoted to comparing the merits of the various types of clothing and other equipment which you were shown. It probably took you the better part of an hour to decide whether you would be more comfortable wearing Canadian shoepacks or hobnailed ankle-boots. You had a long discussion with the salesman as to the relative merits of whipcord, Harris tweed, and gabardine. Even making the choice between a slouch hat and a cloth cap presented a perplexing problem. But this was only the beginning, for you had to decide on a rain-coat, a tent, a cot, blankets, pillows, cartridge-belts, fly-books, cooking utensils, and heaven knows what besides. And after you had made your final decision you were probably far from being satisfied with what you had selected. Yet this outfit, over which you had spent so much thought, was, probably, to be used only during a brief summer's vacation. Picture, then, the task faced by the Quartermaster Corps when it was suddenly called upon to provide complete equipment for some 4,000,000 men for an indefinite period. At first thought it might seem easy enough to purchase clothing for soldiers—a coat, a pair of breeches, an overcoat, a hat, and a pair of shoes for each man—until you are reminded that no one of these simple articles of uniform was standard for civilian use, either in material, pattern, or color. Everything had to be made to order. Everything had, moreover, to be better made than if it were intended for civilian use, for the men for whom these articles were intended were not

going out to shoot elk or catch trout; they were going to a country 3,000 miles away for the purpose of killing Germans, and no one could say how long the business would take them. It was a Titanic task, this equipping of the men who took up arms against Germany. The organization which handled the buying end of it was roughly as follows: in Washington the Clothing and Equipage Division of the Office of the Director of Purchase, where all the activities were centralized; in Philadelphia a purchasing office, which was a branch of the great Quartermaster Depot in that city, and in New York a procurement office which kept constantly in touch with the raw-material markets of the world.

The innumerable special-service units which were constantly being added to the rapidly expanding army required all sorts of strange, new equipment and special clothing. The cooks and bakers had to have cotton aprons and the blacksmiths leather ones. The linemen of the telegraph battalions had to have special gloves. Hoods were needed for the motorcycle despatch-riders, overalls for the men of the stevedore battalions, helmets for the camp firemen, garments of fur and leather for the flying-men. The prisoners began to come streaming in and for them had to be designed clothing which would insure their speedy recognition and recapture in case they attempted to escape. The convalescents at the hospitals needed special suits. The expeditionary troops sent to Siberia and the Murman Coast required outfits which would keep them warm through the long arctic winters.

And uniforms had to be provided for the army's women nurses. Besides this vast quantity of clothing there were tents to be provided, cots, blankets, towels, shaving outfits, brown-canvas bags for filtering water, and the blue-denim bags in which the soldiers kept their personal belongings. These things were not in existence anywhere; they had to be made from the outset. To produce them in the enormous quantities required, not only took the maximum output of all the factories and mills already engaged in the manufacture of such articles, but hundreds of other plants had to change over their machinery in order to meet the army's needs, and the Quartermaster Corps had to send experts to give instruction at these plants in the new manufacturing processes and methods. Nor was it enough for the Quartermaster Corps to thus become itself a manufacturer of clothing and equipment. It had to manufacture the cloth used in the clothing, and, going still further, it had to provide the raw cotton and wool used in making the cloth, as well as the hides for the leather used in the shoes. And it had to produce this staggering volume of equipment quickly, for the Germans would not wait. It was compelled, moreover, to make its purchases in a market glutted with orders from the Allied governments and from the domestic trade. And, to increase the difficulties under which the corps labored, it had to buy on credit, and to do so in the face of cash competition, for Congress did not make sufficient funds available until twelve weeks after the declaration of war. Nevertheless, the whole enormous undertaking was successfully carried

through, and, save in rare instances, the soldiers never lacked for clothing or other Q. M. supplies.

Wool was the most important of the raw products to be procured, since it entered into the composition of more items than any other material. Soon after the declaration of war the Quartermaster Department estimated that about 100,000,000 pounds of scoured wool would be required to meet the initial demands of the army. An inventory of all wool supplies, including wool ordered from abroad as well as the stocks on hand in this country, revealed the startling fact that there was in sight only about 35,000,000 pounds—barely more than a third of the amount needed. To insure the procurement of this wool and to head off speculation in domestic wool prices, for the American sheep were then about to be sheared, the government itself, in July, 1917, entered the wool business. It immediately optioned practically all the wool in the hands of all the dealers in the United States; it fixed a price for the domestic supply for the ensuing year; it arranged to procure the entire 1917 clip if needed; it took over all wool under import licenses, and it sent its buyers to South America and the other foreign markets. There was a wool administrator to buy wool, a wool-purchasing quartermaster to pay for it, and a wool distributor to sell it to the government contractors. Within a year the Clothing and Equipage Division had absorbed the entire wool trade of the United States. In fact, there was no wool market again and no public sale of wool until after the signing of the Armistice.

The largest of the foreign markets which was avail-

able from the standpoint of accessibility was the Argentine. Australia and New Zealand were, of course, enormous markets, but the shortage of tonnage made it impossible to spare many bottoms for the long voyage to the antipodes. As a result of the shipping situation, when the fighting ceased there was an appalling shortage of wool everywhere in the world except in Australia and New Zealand. America was short of wool, there was a little in England, France had practically none, and in Germany and Austria there was none at all. But Australia and New Zealand had *a billion pounds*—and no ships.

At first the better grades of wool appeared to be adequate to meet the demands of the army, but later changes were made in the specifications for various cloths—uniform cloth being increased from 16 to 20 ounces, overcoating from 30 to 32 ounces, shirting flannel from 8½ to 9½ ounces, and blankets from 3 to 4 pounds—which made it necessary to utilize grades of wool which previously had been used only in coarse materials, such as carpet. In order to obtain the necessary weight and warmth, the lower grades of wool were blended with the higher grades, though this frequently entailed a sacrifice of fineness of texture and appearance. This explains why many of the uniforms worn by our returning soldiers looked rough and uneven in color. But the necessary cloth was provided and it was warm and it wore well. The trouble was that it was not provided soon enough. During the autumn of 1917 and the succeeding winter thousands of our soldiers, both in France and in the camps at

home, did not have sufficient clothing to keep them dry or warm. Hundreds of American soldiers went into action wearing British uniforms—even to the buttons bearing the royal cipher and crown!

The Quartermaster Corps introduced endless economies in order to save wool. More economical patterns were made for uniforms. Originally 1.45 yards of cloth were required to make a pair of wool breeches. A cheaper cutting pattern reduced this figure to 1.222 yards, thus saving nearly a quarter of a yard of cloth on every pair. Since the purchases of wool breeches amounted to 10,300,000 pairs, this single economy resulted in a saving of over 2,300,000 yards of cloth on breeches alone. It was also found that cotton linings could be substituted for the wool facings of coats and overcoats without sacrificing either serviceability or warmth. Another important cloth economy came when the designers of the Clothing and Equipage Division eliminated the right-hand pocket of the "O. D." shirt on the ground that this pocket was not used enough to justify the additional expense.

Americans have always believed, or pretended to believe, that, so far as the uniforms of our fighting forces are concerned, smartness is not essential. This is a mental attitude which we inherit, no doubt, from our pioneering forefathers, and which was strengthened by those Civil and Spanish War generals who tucked their trousers in their boots, pulled their slouch hats over their eyes, and wore handkerchiefs instead of collars. So, when the first contingents of the Expeditionary Forces set sail for France, we excused

the obvious shortcomings of their uniforms by asserting that they "looked businesslike and American"—an assertion which was, however, open to some doubt. If our soldiers looked military—*and they did*—it was not because of their uniforms but in spite of them. No one recognized more quickly than the Commander-in-Chief of the A. E. F. that the uniform of the American soldier was lamentably lacking in smartness, a lack which was made painfully apparent when it was contrasted with those worn by the soldiers of the Allied nations. When, therefore, General Pershing recommended the adoption of a smarter-looking uniform, the Clothing and Equipage Division undertook to design one, with, incidentally, an eye to the saving of cloth. The coat of the uniform, formerly called the blouse—a ridiculous and inappropriate designation which is now obsolete—was cut with new lines which made it slimmer and more graceful while retaining all the warmth and comfort of the old garment. As the soldiers usually filled the patch-pockets of their old blouses with all sorts of articles they were usually unsightly bulges, but on the new coat the patch-pocket is retained only in appearance, the pocket actually being on the inside. It is not known to most Americans that the breeches which had been worn by American soldiers for twenty years or more have been replaced by trousers so far as the A. E. F. is concerned. The soldiers themselves were not particularly enamored of the breeches, which frequently caused chafing under the knee and always caused a burst of expletives when a man tried to put them on in a hurry.

Moreover, it was often found impossible for the surgeons to remove breeches from a man wounded in the legs without cutting the cloth and thereby ruining the garment. All these objections have been obviated, however, by the adoption of trousers, which have the added value of increased warmth. Following General Pershing's recommendations, the overcoat, which was much too long to be worn in the trenches, was redesigned, a new garment being evolved which was smarter and more practical. Other changes are the adoption of the spiral woollen puttee in place of the canvas legging and the substitution of the jaunty overseas cap for the impractical and universally unbecoming campaign hat.

The redesigning of the uniform—which, by the way, never appeared in the field—accomplished several surprising economies. Merely by the substitution of trousers for breeches, the lacings, eyelets, tape, and stays thus eliminated amounted to 95¼ cents on each garment, and had the war lasted until July 1, 1919, would have saved the taxpayer nearly $17,000,000 on orders placed or in sight. The change in the design of the overcoat saved 62 cents per garment—an estimated saving, by July 1, of nearly $900,000. It was found that the service coat could be made for $1.60 less than the old blouse, which by July 1 would have effected an economy of close to $5,000,000. The changes in these three garments not only gave the American soldier a much better-looking uniform but it saved the American Government enough money to build a first-class battleship, and, what was most important of all, it effected an enormous economy in

the consumption of raw wool, which, once exhausted, could not be replaced with all the money on earth.

In making its earlier clothing contracts the government paid the contractor a percentage of the value of the yardage which he saved by his economy in cutting and it also permitted him to keep his own clippings. But later on, when the shortage in wool became more acute, the cloth issued to the contractor was calculated more closely, he received no credit for his savings, and all clippings had to be turned in. These clippings were sent to the base sorting-plant in New York, where they were baled and shipped to mills to be used as reworked wool, in blankets and other articles. From September, 1917, to December, 1918, this plant handled over 17,000,000 pounds of wool clippings, the total sales of which produced $5,500,000.

Wool was not only made up into clothing but it went into such knit goods as undershirts, drawers, stockings, gloves, and puttees. This branch of the war woollen-goods industry found itself confronted with a serious problem in the lack of suitable machinery, for though there were numerous manufacturers of knit goods, their mills had been devoted to the production of specialties, such as men's union suits and women's underwear. These concerns had, therefore, to make great changes in their machinery, and sometimes to remodel their plants, before they could knit underclothing in the sizes required for the army. Toward the close of the war every machine in the United States that could make hosiery was knitting socks for soldiers.

At one time there was a serious shortage of needles, which we had formerly obtained from Germany. When this source of supply was cut off we turned to Japan, but the Japanese needles proved anything but satisfactory: they were not properly tempered and their frequent breakage caused much loss and delay. A rumor reached the ears of the Quartermaster-General that there were 10,000,000 knitting-needles in Sweden, whereupon purchasing agents were despatched to Scandinavia post-haste. They returned a few weeks later bringing with them a million needles, which helped to relieve the situation, the American needle-makers meanwhile being pushed to the limit.

Though the production of the regulation service uniform constituted the bulk of the Manufacturing Branch's activities, it was by no means the whole of them. It went into an entirely new field, for example, when it bought uniforms for the women nurses of the army. There was a trim little Norfolk suit of navy blue which cost the government about thirty dollars; a cotton uniform for indoor wear that cost three dollars; a long, belted ulster costing in the neighborhood of twenty-eight dollars; to say nothing of blouses made from navy-blue silk, jaunty hats of blue velour, stout tan walking-boots, and hospital shoes of white canvas. When it came to lingerie, however, the "Q. M." balked. It permitted the nurses to purchase that for themselves.

Then there was the special clothing required for the soldiers fighting on the Siberian steppes and the frozen wastes around Archangel. These garments

were designed by men who had had experience in the arctic and were intimately familiar with the peculiar conditions existing on the world's remotest battle-line. Our soldiers in Russia were supplied with caps and mittens made from muskrat fur, overcoats of moleskin or of duck lined with sheepskin, Alaskan parkas with hoods lined with the fur of the wolf, woodsmen's heavy knee-length socks, Canadian shoepacks, such as the trappers and *voyageurs* wear in the Northern woods, and special heavy underwear. These outfits, which cost about a hundred dollars each, were supplied to approximately 15,000 men.

And, finally, there was the clothing for prisoners of war and interned enemy aliens. This was not manufactured for the purpose but, instead, the uniforms discarded by our own men were dry-cleaned, repaired, and dyed a special shade of green—a glaring emerald-green—so that the wearer could be distinguished as a prisoner as far as the eye could see him. I remember watching a column of German prisoners leaving the prison stockade near Atlanta one morning on their way to work. In the front rank, his red mustache bristling fiercely, was a peculiarly haughty and insolent head steward whom I had known in those days, now long past, when self-respecting persons crossed the Atlantic on German liners. He was fatter than when I had last seen him, and in his bright-green prisoner's uniform he looked for all the world like an animated cabbage. There is a certain appropriateness in the fact that the uniforms with which we supplied our captured Germans cost the government just thirty cents apiece.

For more than forty years the woollen shirts worn by American soldiers have been made at the great Quartermaster Depot at Jeffersonville, in southern Indiana. In order to give employment to as many of those who needed it as possible, it has always been the policy of the depot to distribute the sewing of the shirts among the women of the community, so, upon the outbreak of war, there were some 2,000 sewing operatives working for the government in or near Jeffersonville. When word was received from Washington that shirts were required in enormous quantities and with the least possible delay, appeals were made by means of posters and through the press to the women throughout that region to increase the output of shirts for our soldiers. The response was as quick as it was gratifying. Women who did not need the money gave up their duties or their pleasures and turned to sewing. Soon there was scarcely a woman along that portion of the Ohio who was not, like the industrious Sister Susie, sewing shirts for soldiers. The number of operatives jumped from 2,000 to 20,000 almost overnight; the yearly output of shirts rose from 600,000 to 8,500,000. The operatives were required to call at the depot, where unmade garments, which had already been cut, were issued to them, together with the necessary trimmings and a completed shirt to be used as a guide, the garments being sewn at home and returned to the depot for inspection. In order to care for the thousands of women who came flocking into Jeffersonville to secure shirts, first-aid stations had to be established at the depot. A Sanitary Bureau was

also organized and a corps of sanitary inspectors were employed to visit the homes of all the operatives to see that the shirts were being sewn under proper sanitary conditions. As a further precaution, the shirts were fumigated upon their return to the depot, thus insuring the soldier against any risk of contagion from this source. When the Armistice, was signed the Jeffersonville Depot was the largest shirt-manufacturing establishment in the world, and "The Song of the Shirt" was heard for miles up and down the banks of the Ohio.

In supplying the army with such articles as sheets, pillow-cases, towels, gauze, denim, duck, and webbing, the Cotton Goods Branch of Purchase and Storage procured over 800,000,000 square yards of cotton textiles—enough to have covered an area four times the size of the District of Columbia. It also purchased enormous quantities of burlap for packing, for bags, and for the use of the Camouflage Service, as well as silk for flags, hat-cords, and badges. Though it was never found necessary to resort to the use of paper fabrics, the division had in its possession samples of paper cloth and articles made from it which had been captured from the enemy. These paper textiles were carefully analyzed and studied, and had it become necessary to provide a substitute for cotton, we were prepared to produce one which would have astonished the Germans.

One of the characteristics of the equipment of the European soldier is the number of articles made

of leather. He has leather belts, cross-belts, cartridge-belts, bandoliers, gun-slings, map-cases, knapsacks, sword and bayonet scabbards, chin-straps, and not infrequently his head-gear is likewise made of leather. Not only is all this leather costly, but it is stiff, heavy, cracks easily, and requires constant work to keep it clean. Owing to the extreme scarcity and the almost prohibitive cost of leather, its use was confined in the American Army to saddles, bridles, harness, leggings, and Sam Browne belts, virtually all other articles of equipment formerly made of leather, such as cartridge-belts, packs, bandoliers, scabbards, gun-slings, pistol-holsters, and the like, being made of cotton webbing. To supply the army's enormous demand for these articles it was necessary to convert to the manufacture of this cotton webbing many plants which had theretofore been engaged in the production of hose, cotton belting, and asbestos brake linings. All the plants thus adapted to the emergency manufacture of webbing were dependent on purchased yarns which they had to secure in the open market. In the South, where most of this yarn was produced, the securing of power was a very serious problem. Many of the mills depended upon electricity generated by water-power, so when this water-power ran very low it was necessary for the government to step in and allocate the available power among the mills working on army contracts according to the most pressing needs. Then there was the inevitable question of labor. In many of the plants employees had to be given special courses of instruction before they could produce the new ma-

terials on which they were set to work. In the South, particularly, much trouble and delay was caused by the question of child labor and the working hours for women and minors, for in its later contracts the government inserted clauses insisting on the observance of certain regulations designed to benefit and protect the workers. In some instances contracts were returned to the government because of this child-labor clause, whereupon orders were issued virtually compelling the mills to produce the goods called for, whether they wanted to or not. I doubt if any government in the world, while engaged in a life-and-death struggle, would have found time to show such solicitude for the weakest and least influential of its people.

Next to wool, leather was the most essential of the raw materials required for the equipment of our soldiers, the Quartermaster Corps purchasing 33,000,000 pairs of shoes, 6,500,000 pairs of gloves, and nearly 3,000,000 leather jerkins, in addition to enormous quantities of harness, saddlery, and other equipment. It was early recognized, therefore, that it was as vitally necessary to save every foot of leather as it was to conserve every pound of wool, so, in pursuance of this policy, the Hide and Leather Control Board was formed. This board not only put a check on the use of leather for non-military purposes by restricting the variety of styles in civilian shoes and by similar measures, but it guaranteed an adequate supply of leather to those manufacturers engaged on army contracts. It also maintained a small army of inspectors to examine

the leather at the tanneries as well as the finished products of the shoe, clothing, and harness factories, thereby guaranteeing the quality of the material and frequently improving it. Generally speaking, no action was taken which affected the hide or leather business without calling into consultation the members of the particular trade concerned and coming to an agreement with them as to the quality and price. This procedure, which was followed throughout the war, did much to eliminate all friction and misunderstandings, and enormously speeded up production.

Hanging always over the heads of the board was the menace of a leather shortage, and its members lay awake nights devising plans by which such a calamity could be averted. To illustrate the seriousness of the situation, it was estimated in July, 1918, that in another twelvemonth something like 13,000,000 hides would be required for the use of the army alone. As this is the entire output of hides in the United States. it was realized that were the war to continue through the winter, there would be no leather left in the United States by spring. Faced by this critical situation, the board called to its aid the foremost tanners, shoe and harness manufacturers in the country, and it was due to their services in checking up the figures submitted by the trade, in keeping down the manufacture of non-essential articles, in unearthing thitherto unsuspected sources of leather supply, and in introducing more economical methods of cutting, that during the latter months of the war the army rarely lacked for leather equipment. I have already told how great economies

in the consumption of leather were effected by the substitution of cotton webbing in the manufacture of certain articles. During the second spring of the war the women of America suddenly found that they were no longer able to obtain the extremely high-topped boots which were then the fashion, while men had to content themselves with plain instead of "wing" tipped shoes. The leather thus saved was used in the manufacture of footwear, gloves, and jerkins for the men who were offering their lives in the trenches in order that the people at home who wore the high-topped boots and the wing-tipped shoes might continue to live in safety. Many persons have wondered why officers serving in the United States were not authorized to wear the Sam Browne belt. I can give them one of the reasons. It was because the necessary leather could not be spared for a purpose which was, after all, purely ornamental. As a result of this admirable system of supervision and control the Quartermaster Corps was not only able to fill with reasonable promptness the requirements of our troops overseas, but when the Armistice was signed, it had enough leather equipment, either manufactured or in process of manufacture, to supply an army of 5,000,000 men.

In none of its innumerable forms of endeavor did the Quartermaster Corps more strikingly demonstrate its genius as a manufacturer than in the design and production of the army shoe. Before the war our soldiers wore a machine-sewed shoe of russet calf lined with duck, very similar to civilian footwear of the bet-

ter grade. Shortly after the beginning of hostilities, however, the War Department adopted a new and much stouter shoe. This new model had a much heavier upper than the old one, with the flesh or rough side out and the grain side in, and with no lining, while, instead of a single sole, as in the old shoe, two heavy soles were used, the bottoms of which were thickly studded with hobnails. But even these, formidable in appearance as they were, did not prove stout enough to stand up under the incredible wear of trench warfare, so there was finally developed the so-called "Pershing shoe." These really should have been classified as tanks instead of shoes, for they could go anywhere, they could withstand any amount of use or abuse, and they were, literally speaking, armored. The "Pershing shoe" has three outer soles which are fastened to an inner sole of outer-sole quality and thickness, first by nailing, then by screws, and finally by stitching with heavy linen thread; the toe is reinforced with a moulded steel plate; both sole and heel bristle with hobnails, and, as a final touch, the heel has a heavy steel horseshoe around its edge. It was by long odds the best shoe worn by any army. In fact, no such footwear was ever produced before. The pity was that it did not reach our troops sooner.

Before we had been at war a month a most troublesome fact came to light in connection with the question of shoes. It was found that the old schedule of sizes was entirely wrong and did not begin to meet the new conditions. In the old army the individual men were carefully selected according to a certain standard

of measurement, and it was, therefore, a simple matter to fit them with shoes from a comparatively restricted range of sizes. But the millions of men who were called to the colors by the draft represented all types except the physically defective. In the ranks of the recruits a 250-pound policeman who had spent the better part of his life on his feet would be found shoulder to shoulder with an anæmic-looking little clerk who had spent most of his life perched on an office-stool. A man whose feet had always been incased in the flexible pumps of a professional dancer might find himself rubbing elbows with a cow-puncher who wore high-heeled Mexican boots and who had always lived in the saddle. As the raw levies began to round into shape at the training-camps, it was found that clerks, professional men, and others who had not been accustomed to working in the open air developed in size with amazing rapidity. This was particularly true of the men's feet, for after a few long hikes with a full pack, a recruit could not squeeze his feet into shoes of a size which he had theretofore worn with perfect comfort. This meant that an entire new series of models and lasts had to be made, running up to unheard-of sizes, as, for example, 17-EEE! The standard sizes of the army shoe at present range in length from 5 to 15 and in width from A to EE, thus making it necessary to carry each style of shoe in *one hundred and twenty sizes.*

Now, no article of clothing can cause such acute discomfort and so quickly affect a man's disposition, and consequently his morale, as an ill-fitting shoe.

The Germans were the first to appreciate the importance to an army of caring for the men's feet, and with their customary thoroughness took steps to prevent foot-trouble from the very beginning of the war. I remember remarking, when I was with the Ninth German Army during the first weeks of the invasion in 1914, that following each regiment of infantry was a huge motor-truck carrying a complete pedicure establishment—a sort of chiropodist's office on wheels. Whenever a soldier developed a bunion or a corn or an ingrown nail, whenever his boots pinched his toes or chafed his heel, he fell out of the ranks and waited for the pedicure wagon—I don't remember the German name for it—to come along, climbed up, sat in a chair, and the attending chiropodist tended his feet and, if necessary, issued him another pair of boots. "The feet of the soldiers?" said a German general to whom I mentioned the matter. "They no longer belong to them after the Empire goes to war—they belong to the Emperor. A soldier is no more permitted to abuse his feet than he is to abuse his rifle. They must always be in condition for marching and for fighting the Emperor's battles."

Profiting by the example of our enemy, we exercised the utmost care in fitting our men with footwear. As the result of examinations conducted at a number of training-camps, it was found that out of nearly 60,000 men examined, slightly more than 71 per cent were wearing shoes which were too long and nearly 10 per cent shoes which were too short, only one man in five having shoes of the proper size. These figures

were sufficient to demonstrate to the War Department the necessity for extraordinary care in the fitting of soldiers' shoes, and led to the establishment at Camp Meigs, D. C., and Jefferson Barracks, Mo., of schools for foot-measuring and shoe-fitting. Two officers from every camp and cantonment in the United States were detailed to take this course of instruction, which lasted five days and consisted of lectures, demonstrations of the various appliances, and practical training, the latter being acquired by each officer actually measuring and fitting a thousand men with army shoes under the direction of competent instructors.

The coal which was required for heating and cooking in the various camps and cantonments both in the United States and France, the coke which was used at our arsenals in the production of ordnance, the gasoline which drove our trucks, tractors, tanks, and airplanes, and the oils which lubricated them, were all procured through the Fuel Branch of the Fuel and Forage Division of the Office of the Quartermaster-General, which in October, 1918, was converted into the Raw Materials Division of the Office of the Director of Purchase and Storage, without, however, in any way affecting its functions. From its creation by the President in August, 1917, until the close of the war, the United States Fuel Administration worked in closest harmony with the Fuel Branch of the Quartermaster Department in supplying the enormous fuel requirements of our fighting forces. The procedure was roughly as follows: The Fuel Branch first ascertained

the probable requirements of every camp, post, and station for each month of the fiscal year, and upon receipt of these estimates it would request the Fuel Administration to allocate to the respective camps the tonnages required. Pursuant to these requests, the Fuel Administration would instruct its District Representatives to place the necessary orders with the various coal-shippers, the regulation of shipments and similar matters thenceforth being handled by the District Representatives directly with the Camp Quartermasters. With the abolition of the Fuel Administration at the end of the war, the task of supplying the army with coal and coke devolved upon the officers in charge of the various General Supply Zones into which the United States is now divided.

The prime importance to the army of gasoline and lubricants was made clear by General Pershing when he placed them, with food and forage, in the first division of the automatic supply cable which governed and controlled the movement of all supplies that had to go forward daily to the combat troops on the line. To procure and maintain an adequate supply of petroleum products, and to devise and standardize these products, there was created the Oil Branch of the Fuel and Forage Division of the Quartermaster Corps. Many interesting problems were successfully solved by the Oil Branch, which received assistance of the greatest value from the producers and refiners. Though the oil producing and refining concerns of the United States have repeatedly been characterized by politicians and by the press as "soulless corporations,"

their patriotism throughout the great emergency was shown by the fact that their interest and efforts did not end with providing what the government asked for, but every one connected with them, from their presidents down, regarded the matter of supplying the army as a personal responsibility, suggesting many valuable changes, improvements, and economies based on their technical knowledge and experience.

For the benefit of those unfamiliar with the oil industry, I ought to explain that there are many grades of gasoline, differing in character or in method of production. Commercial gasoline, for automobile use, included grades known as "straight-run," "casing-head," "blended," "pressure still," and "cracked." In order to standardize gasoline for army use the Fuel and Forage Division worked out, with the co-operation of the refiners, certain specifications, with the result that a gasoline called "Quartermaster Specification" was adopted as a standard fuel. It is known as "428° gasoline," and is used for motor cars, trucks, tanks, and cycles. For aviation purposes three other grades were produced; two of which, 257° "Fighting Naphtha" and 302° "Export Aviation," were furnished only to the American Expeditionary Forces. "Fighting Naphtha" is the highest refinement of gasoline ever produced in quantity, being produced by "rerunning" Export Aviation and taking off the "cream" of that extremely high-grade fuel. To distinguish it as the finest motor-fuel in existence and to prevent its indiscriminate use, a small amount of aniline dye was added to color it red. Its use was confined to scout and battle

planes, thus giving our flying-fighters an immense superiority over those of our allies or of the enemy, and thereby lending them the confidence which is required for daring deeds. Indeed, many a Hun flier was brought to earth, many a D. S. C. was won, as much by the qualities of the scarlet fuel as by the courage of the aviator. Who says that there is no romance in gasoline?

Though this is the greatest horse-breeding nation in the world, and though Americans fondly think of themselves as a nation of horsemen, no one of the warring countries found itself so utterly unprepared in respect to remounts as the United States. The importance with which the War Department had regarded the question is best illustrated by the fact that at the outbreak of the war remount matters were in charge of one officer, with two civilian clerks, as a subsection of the Transportation Branch of the Quartermaster-General's Office. For a number of years prior to the war repeated efforts had been made by enthusiastic horsemen, both in the army and out of it, to induce the government to undertake the breeding of cavalry and artillery mounts on a large scale, or at least to encourage their breeding by farmers, as has been done for centuries by certain of the European nations. But the parsimony of Congress, combined with the lack of vision of officers high in the military councils of the nation, blocked all these plans, and though one or two government studs were established with animals presented by public-spirited breeders,

so little of real value was accomplished that of the 458,000 animals purchased during the war by the Remount Service, only about 5,000 were horses bred specially for military purposes.

Upon the outbreak of the war it became necessary, therefore, to scour the country for suitable animals, which had, perforce, to be purchased in the open market, which had already been gone over with a fine-tooth comb by British, French, Italians, and Russians, all of whom had maintained remount commissions in this country from the very beginning of the conflict. Fortunately for us, under the circumstances, the requirements of the Expeditionary Forces were confined to officers' mounts, artillery horses and mules, only one regiment of cavalry, in addition to the headquarters troops of the various divisions, being sent overseas. There were, however, demands for large numbers of horses for the use of the two cavalry divisions which were in process of organization in this country, and for the cavalry regiments which were kept on patrol duty along the Mexican border.

As soon as it became apparent that it would be necessary for the government to make large purchases of horses and mules, hundreds of horse-breeders, racing and hunting men and polo-players offered their services as purchasing agents. Some fifty of these gentlemen, as shrewd judges of horse-flesh as the Blue Grass region of Kentucky, the hunting-fields of Long Island and Virginia, and the show-rings and race-courses of the great cities could produce, were given commissions as captains in the Quartermaster Corps, and were sent

to the headquarters of the various purchasing zones for a short period of practical instruction in the type of horse required by the army, and in army methods generally, before being sent on the road to purchase animals. How efficiently and conscientiously these officers, unaccustomed to military methods, performed their duties is shown by the exceptionally high class of animals which they purchased and shipped to the various auxiliary remount depots, where they were trained and conditioned for army use. As the dearth of tonnage placed a limit on the number of animals which could be shipped overseas, a number of remount officers were sent to Europe, where large purchases of live stock were made, about 110,000 horses and 10,000 mules being bought from the French, some 12,000 horses and 6,000 mules from the British, and upward of 12,000 mules—the big, 16-hand Andalusians—in Spain.

At the beginning of the war there were only three remount depots in the United States—at Front Royal, Virginia, Fort Keogh, Montana, and Fort Reno, Oklahoma—together with auxiliary depots at Fort Bliss and Fort Sam Houston in Texas, but with the rapid expansion of the forces it was found necessary to establish an auxiliary remount depot adjacent to each of the thirty-three camps and cantonments of the National Guard and the National Army. This naturally necessitated an enormous increase in the Remount Service personnel, which shortly before the Armistice numbered 400 officers and 19,000 enlisted men. As the war progressed it became increasingly difficult for

the Remount Service to meet the demands made by the auxiliary depots for officers, for the available supply of amateur horsemen who had volunteered their services quickly became exhausted, many of them going into other branches of the army. In order to meet this demand camps were organized at Camp Joseph E. Johnston, near Jacksonville, Florida, and at Camp Shelby, Hattiesburg, Mississippi, where enlisted men who possessed the necessary qualifications were trained for commissions as officers. There was also established at Camp Johnston a mobilization camp for the organization and training of Field Remount Depots, but as this organization did not prove sufficiently flexible, there was authorized a smaller unit, known as a Field Remount Squadron, consisting of 6 officers and 157 enlisted men, it being estimated that one squadron would be required for every replacement of 400 animals. And replacements were, of necessity, frequent, it having been estimated that the average life of a horse in France was only sixteen days. There were organized at Camp Johnston a total of sixty-three Field Remount Squadrons, three wagon companies, and twelve pack-trains, of which all but seventeen squadrons saw service abroad. The enlisted personnel of these squadrons consisted of drafted men who were carefully selected because of their knowledge of horses, most of them having been farmers, ranchmen, cow-punchers, and, in a few cases, jockeys. Provision was also made for training the enlisted specialists attached to each squadron, schools being established for horse-shoers, saddlers, farriers, teamsters, and squadron

clerks. Indeed, there was no more interesting sight at a cantonment than the Remount Depot, where bronco-busters, fresh from the ranges, could be seen breaking unruly horses in the "bull-pens," while veteran packers and plainsmen gave instruction to classes of raw recruits in the art of harnessing and driving a six-horse "swing" or of throwing the "diamond hitch."

The chief function of the Quartermaster Corps might be described, I suppose, as spending. It was, in fact, barring the Ordnance Department, the greatest spending agency in America, if not in the world, during the war. Not many persons are aware, however, I imagine, that it has a division whose sole purpose is saving. I refer to the Salvage Division. This was the only organization in the army which turned waste into profit. It was a ragpicker, a garbage-collector, a junk-dealer, and an ole-clothes man combined. While certain departments of the government seized on the great emergency to spend money like a drunken sailor, as the politicians put it, the Salvage Service was as systematic a saver as the late Russell Sage. And, like that famous financier, it was able to show something for its savings—to be exact, something over $100,000,000. It had a perfect passion for economy. It saved everything, from the pieces clipped from a soldier's overcoat when it was shortened to the food which he left on his plate. Nothing was too large or too small to escape it. Indeed, the members of the Salvage Service should have adopted for their shoulder-badge a design showing an ever-open eye. If a loco-

motive was utterly demolished in a railway wreck the men of the Salvage Service appeared on the scene almost before the wheels had stopped turning and collected the splintered remnants. If a soldier tossed a pair of worn-out socks into the garbage-barrel, the Salvage Service fished them out and used them for something or other. In France it saved and sorted the millions of sand-bags which lined the parapets of the trenches; it untangled and rerolled for future use the millions of feet of twisted, rusted barbed wire which formed the entanglements in front of the trenches; it gathered and sorted and sent back for reloading the empty shells from the field-guns; it fumigated and cleaned and pressed the soldiers' uniforms; it washed their shirts and socks and underwear; it mended their shoes; it transformed their obsolete campaign hats into felt slippers, and both in this country and abroad it collected the waste from the mess-tables as well as introducing various methods of food-saving; it operated hundreds of camp and mobile laundries, where for a dollar a month a soldier could have washed all the clothing he wished; it ran farms and truck-gardens at the camps and cantonments in order to supply the troops with fresh vegetables; it maintained printing-shops, wagon-repair shops, carpentry-shops, and paint-shops, and just as the Treasury Department appealed to the country to "Buy! Buy! Buy!" so the Salvage Service, by means of posters and placards, appealed to the army to "Save! Save! Save!"

In the happy, careless, easy-going days before

the war, the question of repairing the worn shoes and clothing of the soldiers was not considered of sufficient importance to merit even passing attention from the War Department. The army was small, material was plentiful, and the clothing belonged to the soldier. The government issued a man a uniform and out of his pay required him to keep it clean and in repair; if his clothing did not present a neat appearance, he received a reprimand or a court martial. When his shoes wore out he had to have them mended at his own expense—all out of the munificent salary of fifteen dollars a month! But under the new system, introduced at the beginning of the war, the soldier's clothing is the property of the government, and the government undertakes to keep it clean and in repair. And that is where the work of the Salvage Service comes in.

Within five months after its entry into the war the United States, profiting by the experience of the Allies, took steps toward the organization of a branch of the army which would devote itself to the conservation and reclamation of articles and materials which would otherwise be wasted. Pursuant to this policy there was established in October, 1917, the Conservation Branch of the Supplies Division of the Quartermaster-General's Office with a personnel of two officers and a stenographer. Within less than a year this little nucleus had expanded into the huge Salvage Division of the Office of the Director of Purchase and Storage, with 500 officers, 20,000 enlisted men, and 2,000 civilian employees. The work of this division has consisted,

AMERICAN SALVAGE DUMP IN FRANCE.

"The salvage service had a perfect passion for economy."

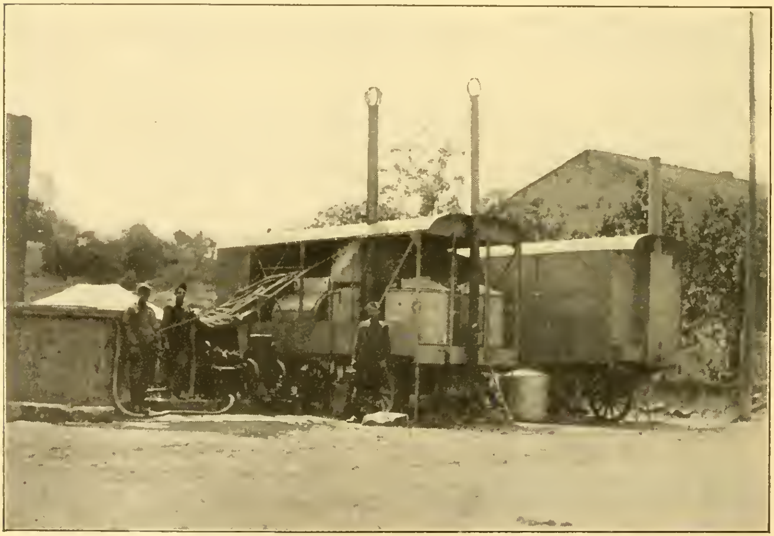
Photograph by Signal Corps, U. S. A.

A WORKROOM IN AN AMERICAN SALVAGE DEPOT IN FRANCE.

The salvage service fumigated, cleaned, pressed the soldiers' uniforms, washed their shirts, socks, and underwear. It mended shoes and transformed campaign hats into felt slippers.

AN AMERICAN DELOUSING STATION.

The weary men returning from the trenches found the delousing and fumigating stations set up and awaiting them.



Photograph by Signal Corps, U. S. A.

AN AMERICAN LAUNDRY IN OPERATION NEAR THE FRONT.

Each of these units can wash the clothing of 10,000 men, fresh from the trenches, weekly.

generally speaking, in cleaning, laundering, repairing, renovating, and otherwise looking after the uniform and equipment of the American soldier, and in those cases where the uniform or equipment was too badly damaged to be worth repairing, the service has devised means of using the sound material for other purposes. During the six months beginning April 1, 1918, the service salvaged nearly 9,250,000 articles of clothing and equipment. The value of these articles when new was something over $41,000,000. After their repair it is estimated that their value was in the neighborhood of $29,000,000. The total cost of repair was a little more than $2,500,000, leaving a net saving due to this salvage operation of about $23,500,000. Quite a tidy sum. During four months of 1918 the Salvage Service collected approximately 43,000,000 pounds of junk, including old metals, iron, rubber, cotton and woollen rags, rope, paper, leather, and horsehair. About 3,000,000 pounds of this material, having an estimated value of $769,000, was reissued for army use, while 19,000,000 pounds was sold for $508,000, leaving 23,000,000 pounds still to be disposed of. Had it not been for the Salvage Service, practically all this would have gone to waste. In addition this division collected a great quantity of lumber, mostly odds and ends, of which $25,000 worth was reissued for army use and $475,000 worth was sold, leaving approximately 1,750,000 board feet on hand. From May to November, 1918, the Salvage Division collected and sold $300,000 worth of garbage, and nearly $200,000 worth of manure and condemned hay and straw, to say nothing of dead

animals to the value of $5,000, thus netting upward of $500,000 from the swill-pail, the manure-pile, and the bone-yard alone! The American soldier likes to sit down to his meals with a heaping plate before him, and as he rarely eats everything on his plate, an enormous amount of perfectly good material finds its way to the garbage-barrel. It is estimated that prior to July, 1918, every man in the camps in the United States wasted approximately two pounds of food per day in this fashion. Then the machinery of the Salvage Service was set in operation, it being estimated that in five months, on the basis of 1,000,000 men, it saved *nearly a quarter of a billion pounds of foodstuffs.*

Another activity of the Salvage Corps was the operation of hundreds of camp and mobile laundries. When war was declared the government owned fourteen small steam-laundries which provided for the needs of the few hundred men stationed at the posts where they were located. But with the declaration of war and the concentration of hundreds of thousands of men in the various cantonments, the laundry question assumed such serious proportions that nineteen cantonment laundries were hastily erected and placed in operation. The urgent need for these laundries is illustrated by the fact that on September 1, 1918, nearly 6,000,000 pieces of clothing were awaiting laundering. Quite a wash-basket, wasn't it?

The Mobile Laundry Unit was one of the novelties introduced by the Great War. Instead of the soldiers being compelled to take their soiled clothing to the laundry, the laundry came to them. No matter how

remote the town in which their rest billets might be located, no matter how exposed it might be to the fire of the enemy's long-range guns, the weary men, returning from the trenches, found the mobile laundry set up and awaiting them. Each unit consists of a large steam-tractor and four trailers. When erected for operation the trailers form a room thirty feet long and twenty-eight feet wide, with power provided from outside by the tractor. The trailers contain two large washing-machines, two extractors, a drying tumbler, hot and cold water tanks, a pump to lift water from wells and streams, a soap-tank, and a dynamo for electric lighting. Each of these units, by operating twenty-four hours a day, can wash the clothing of ten thousand men, fresh from the trenches, weekly. So rapidly and systematically was the work done that when the men left the "wash-up" and "delousing" stations, after having rid themselves of the filth and vermin acquired at the front, they found clean clothing awaiting them. And clean clothing—and this I say from experience—means more to the soldier than anything save a bath and food.

The Salvage Service has been one of the least advertised, as it has been one of the most efficient, branches of the army. Probably not one out of a thousand readers of this book was previously aware of its existence. Yet during the twelve months of 1918 it saved to the government, either in articles repaired and reissued or in materials saved and sold, *one hundred and one millions of dollars*. (If this does not impress you, let me remind you that the entire appropriation

for the support of the army for 1898—the year of the Spanish-American War—was only a little over $70,000,000.) It has developed what was formerly a liability into a tremendous asset. It has conserved untold quantities of raw materials at a time when those materials were most vitally needed and were most difficult to obtain. By again and again repairing and using worn-out clothing and equipment and thereby permitting the shipment of vital necessities, it saved thousands of tons of shipping at a time when every ton counted.

If, in this impressionistic sketch of the activities of the Salvage Service, and of its parent, the Quartermaster Corps, I seem to have indulged too freely in the use of figures, it is because those figures are of vital concern to *you*. They represent *your* dollars, Mr. Reader; they show where the money from *your* Liberty Bonds has gone.

V

ORDNANCE

THE history of mankind is punctuated by a few examples of endeavor which, by reason of their magnitude, cannot be fully comprehended by the human mind. That phase of America's part in the Great War comprised in the work of the Ordnance Department of the Army is one of them. It has been termed, and without exaggeration, the greatest effort, directed by a single head, of all time. It was incomparably the greatest industrial undertaking that the world has ever seen. Therein lies the difficulty of writing an adequate story of ordnance—it is too big, too complex, for any writer entirely to grasp, for any reader completely to comprehend. It is like attempting to describe the grandeur of the Grand Canyon; so stupendous a thing can neither be translated into words nor encompassed by the mind. The best that I can hope to do is to sketch a few of the most salient features of the great story in barest outline.

First of all, I would wish to convey to you some conception of the vastness of the organization commonly referred to as Army Ordnance, the immensity of the sums which it expended, and the enormous quantities in which it dealt. It has been said that a billion is too huge a figure for any one to comprehend. Scarcely a billion minutes have elapsed since the birth of Christ. Yet the estimated cost of the ordnance required to supply our first 5,000,000 men was nearly

thirteen billions of dollars. But that is, after all, merely an endless caravan of ciphers. Here is another way of expressing it. Between the signing of the Declaration of Independence and the declaration of war against Germany, the sixty-four successive congresses of the United States appropriated but twenty-six billion dollars for every purpose of government, including the cost of five wars, the pensions resulting from those wars, the upkeep of the Army and Navy, the activities of the State, Interior, Treasury, Agriculture, Commerce, and Post-Office Departments, the control of immigration, the administration of justice, river and harbor improvements, public buildings and public works of every description, the salary of every government employee from the President of the United States to the keeper of an obscure lighthouse in the Philippines, these countless items representing in the aggregate the total expenditures, over a period of more than seven-score years, of the richest nation in the world. Thus it will be seen that, had the war continued for another five months, a single branch of the army would have expended approximately one-half as much as the nation expended from its foundation to the date on which it entered the great conflict. Combine the wealth of all of America's millionaries, add the value of all of America's railways, throw in the Standard Oil, the Western Union, the Ford Motor Company, and the United States Steel Corporation for good measure, and you will still fall far short of the staggering total which the United States had planned to invest in ordnance. Or, if these compari-

sons are not sufficiently graphic, the Ordnance Department would have spent enough in the first two years of war to have built twenty-four Panama Canals, to have purchased the entire city of New York, at its assessed valuation, twice over, or to have built 36,000,000 Ford cars—one for every third person in the United States. That is the best that I can do to give you a realization of the immensity of the task assigned to the Ordnance Department.

Ordnance! No word in the whole lexicon of war held so much significance for the fighters at the front —and so little for civilians at home. For ordnance is the bed-plate of the whole military machine. If it breaks or gives way the machine instantly stops running. An army can fight without cavalry, without aircraft, without tanks, without machine-guns, yes, even without artillery, but no army can fight, or ever has fought, without ordnance. It is as essential to the functioning of an army as oil is to the burning of a lamp. Behind the belching *soixante-quinze*, behind the crackling musketry, behind the lumbering, elephantine tanks, behind the *escadrilles* of airplanes, was the huge organization, its head on the Potomac and its tentacles reaching westward to the Pacific and eastward to the Rhine, which provided the fighting-men with weapons and kept the voracious maws of those weapons supplied with their steel food. The combat troops up on the line knew that should the great Ordance machine break down, even for an hour, they would be compelled to retreat or surrender. The generals knew it. The statesmen and politicians in Paris

knew it, too. And the Germans knew it best of all, as is testified to by the labor troubles which they fomented and the fires and explosions which they caused. You didn't know that the work of the Ordnance Department was so important, eh? Yet, if I remember rightly, you were always asking why the Allies didn't end the war by destroying a certain German ordnance establishment called Krupps.

What is ordnance? It were easier to tell what it is not. It is artillery of all types and calibres, with mounts, carriages, and ammunition; small arms of every description; every kind of explosive used in warfare; an endless variety of gas-driven, steam-driven, horse-drawn, and hand-drawn transport; all harness and horse equipment, save that used by the Quartermaster Corps; tools, machinery, and material for making or repairing everything included in the term—in short, every tool used in the fighter's trade.

Dawn on the Western Front. Everything is in readiness for a great infantry attack. For weeks past the preparations have been in progress. The roads leading to the front have been ground to powder by the endless processions of heavy-laden motor-lorries bringing up food, ammunition, and supplies. The advanced dumps are piled high with cases of rifle and machine-gun cartridges, trench-mortar ammunition, shell of every calibre and kind, all stencilled with the flaming bomb which is the trade-mark of the Army Ordnance. Up in the forward observation-posts intelligence officers are peering anxiously through periscopes

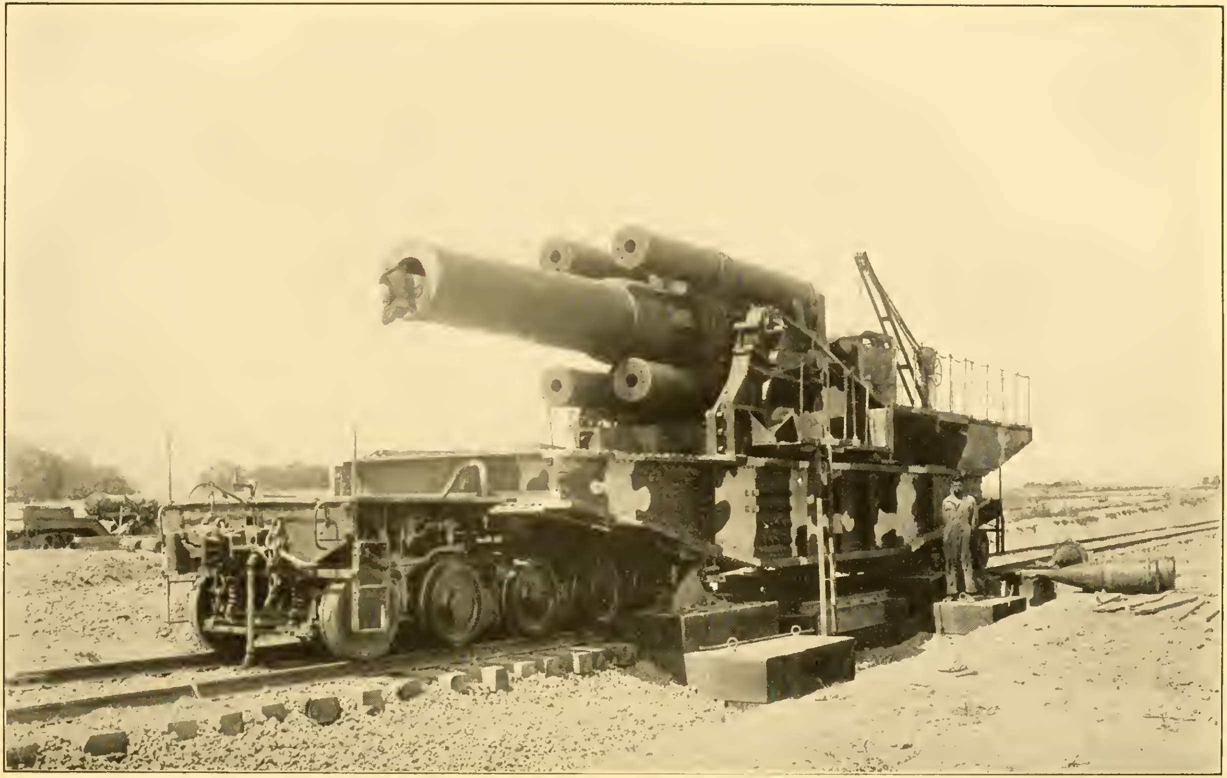
into the fog-hung wastes of No Man's Land. In the assembly trenches the storm troops are waiting in silence on the tapes which mark the positions of the various units, the faces of the men showing grim and determined under their steel helmets. Each wears a belt containing a hundred cartridges in clips; his bayonet is fixed. The men of the medical detachments, distinguished by the broad-bladed bolos at their hips, lean against their up-ended stretchers, waiting for the beginning of the bloody business which will stain those stretchers red. The officers, a trifle nervous and self-conscious, stroll up and down the ranks, examining their automatics or glancing at the luminous dials of their wrist-watches to note the approach of the zero hour. Rifles, bayonets, pistols, bolos, periscopes, cartridges, together with the clips which hold them and the belts in which they are carried—all are ordnance.

A mile or so in the rear the artillery is likewise waiting, every man at his post. The slim steel projectiles have been shoved home and the breech-blocks closed upon them; the barrage-tables have been worked out to a second, the ranges to a yard; the lids of the caissons are raised, revealing the brass heads of the shell waiting in their pigeonholes; the gunners are grasping the lanyards. Each battery commander stands motionless, one arm raised high, eyes glued to his carefully synchronized watch. The minute-hand, creeping forward slowly—oh, so slowly—rests at last upon the hour set for the beginning of the barrage. The upraised arms drop like semaphores,

the watching gunners pull their lanyards, and the heavens seem to split asunder as tongues of flame leap from the eager guns. An instant later thunder and lightning burst above the distant German trenches. Steel falls upon them as water falls over the precipice at Niagara. The earth shakes, the air quivers to the hell of sound. The cannoneers, as though suddenly awakened from a trance, leap into action. Bearing in their arms the steel messengers of death, they dash between the caissons and the guns, sweating like stokers on a record-breaking liner. Farther to the rear are the midcalibre pieces, the "four-point-sevens," the five and the six inch guns and howitzers, whose great projectiles go shrieking Rhineward with a noise like giants tearing mighty strips of linen. Huge howitzers, streaked like zebras and spotted like giraffes by the camoufleurs, their ugly snouts pointing toward the sky, some drawn by panting tractors, others mounted on the tractors themselves, come plunging and rocking across the broken and all but impassable terrain to take up new positions. The dusty roads are lined for miles with columns of gray trucks laden with ammunition, for the stream of shell between the dumps in the rear and the batteries at the front must never, even for an instant, halt or check. So close are the trucks that an active man could, it seems, travel for miles, without ever setting foot to the ground, by leaping from the tail of one to the hood of another. A fragment from a German shell shatters a gun and puts it out of action. As though by magic two great trucks, tabloid factories on wheels, one a mobile ordnance

A 16-INCH HOWITZER.

Huge howitzers, streaked like zebras and spotted like giraffes, point their ugly snouts toward the sky.



A 16-INCH HOWITZER ON A RAILWAY MOUNT.

Camouflaged monsters on railway mounts which can drop a ton of explosives on a given target twenty miles away.

repair-shop, the other a storeroom of spare parts, appear on the scene, and skilled mechanics, wearing on their collars the bomb insignia of the Ordnance Department, repair the damaged gun, heedless of the fact that death is raining all about them, and put it into action again. From their cleverly camouflaged positions far in the rear the great 8 inch and 9.2 inch howitzers, and the 8, 10, 12, and 14 inch guns on railway-mounts are methodically pounding the enemy's back areas, shelling his roads and bridges, destroying his ammunition-dumps and railroad-stations, their monster projectiles cleaving the air with a roar like invisible express-trains. Save only the men themselves, everything—guns and howitzers, shrapnel and high explosive, carriages, railway-mounts, tractors, trucks, limbers, caissons, even the harness on the horses—is ordnance.

From out of the smoke, so close behind the rolling barrage that they seem to be moving amid the bursting shell, a long line of tanks—elephantine monsters of the Mark VIII type and little, agile, humpbacked whippets—waddling forward across the welter of No Man's Land, wading through ooze and slime, clambering over heaps of débris, crushing wire entanglements as easily as though they were made of string, rearing themselves against the walls of concrete pill-boxes and then crashing down upon them, straddling in their stride the yawning chasms of the German trenches, but always pushing forward, like terrible and ruthless prehistoric monsters, one-pounders and machine-guns spurting death from the loopholes in their armored flanks. Tanks and tank-guns are ordnance, of course.

The barrage abruptly lifts, and the eager infantry, pouring out of the trenches, sweeps forward with a roar. Out in front, forming a thin fringe to the leading wave of the assault, are the autoriflemen, playing streams of lead on the enemy trenches from their Brownings and Chauchats as a street-cleaner plays a stream of water upon the asphalt from his hose. As the barrage lifts, the Germans, emerging from the dugouts where they have taken shelter, man their parapets, but volleys of hand-grenades drive them back again. Through the wire demolished by the tanks and into the shell-shattered trenches swarm the cheering Yanks. Parties of "moppers-up" hasten from dugout to dugout, calling upon the occupants to come out and surrender, and when they do not comply, tossing hand or gas grenades into the entrances or wrecking the dugouts with mobile charges. The captured positions are quickly organized. Machine-guns and trench-mortars are brought up and placed in position. Carts and voiturettes, ammunition-laden, some drawn by mules, others by hand, come forward at the double. An enemy machine-gun nest is located and promptly demolished by a pair of Stokes mortars, which send their bombs somersaulting through the air, as a juggler tosses bottles, in an unending stream. Then the enemy launches a counter-attack, the gray-clad hordes advancing doggedly while the rifle-fire crackles along the trenches and the machine-guns go into action with a clatter which sounds like a boy drawing a stick along the palings of a picket fence. Rifle-grenades and shell from the little 37-mm. infantry cannon burst amid the

advancing Germans, gaps appearing here and there amid their close-locked ranks as patches appear in a moth-eaten fur when it is beaten. Before this hail of death the counter-attack falters, checks, crumbles, and finally breaks, as an ocean roller dissipates itself against a concrete pier in futile spray. Everything used in the assault and in the repulse of the counter-attack—service and automatic rifles, 37-mm. cannon, rifle, gas and hand grenades, machine-guns and trench-mortars, ammunition-carts and voiturettes, mobile charges—is furnished by the Ordnance Department.

Reports come in that the enemy is reforming his shattered columns in the shelter of a ridge, preparatory to launching another attack, whereupon the brigade commander orders a machine-gun company to open indirect fire, the rain of bullets mowing down the unseen and now thoroughly demoralized Germans as effectually as though they were advancing in close order across the open. Not only the machine-guns themselves, the tripods on which they are mounted, the ammunition, the belts in which it is contained and the carts in which it is brought up, but the delicate scientific instruments necessary for indirect fire—panoramic sights, clinometers, transits, angle-of-sight instruments, alidades, squares, protractors—are all provided by Army Ordnance.

Meanwhile, simultaneously with the conflict on the ground, an aerial battle has been in progress high in the blue, the German airmen, clearly distinguished by the huge black crosses painted on the under side of their planes, attacking the American flyers who are

engaged in locating and photographing the enemy positions and in directing the fire of the American guns. To the support of the slow-moving observation and artillery planes speed the fighters of the *escadrilles de chasse*, their stripped machine-guns, synchronized to fire between the blades of their propellers, blazing away at the rate of 1,200 shots a minute. Their machine-gun belts are loaded with tracer, armor-piercing, and incendiary cartridges in rotation, the first permitting the gunner to correct his aim by following the bullet's flight, the second to pierce the armored tanks of the enemy machines, the third to set them on fire by igniting the leaking petrol or to destroy observation-balloons, while the belts themselves, made of disintegrating steel links, fall apart as they are fired. Giant bombing planes, keeping to the upper levels, head for the German back areas to drop their ugly eggs, ranging in size from the comparatively small bombs used against troops in the open to the 1600-pound monsters which produce craters 100 feet in diameter and 50 feet deep, upon the enemy's dumps, warehouses, roads, bridges, and railway-stations. Everything save only the airplane itself—the synchronized machine-gun, the disintegrating belt and the special ammunition, the bombs in all their varying sizes, the mechanisms for suspending and releasing the bombs, the sights to determine the exact moment for release, even the ingenious electrical heaters for preventing the lubricating-oil in the guns from freezing at high altitudes—all these are provided by Army Ordnance.

Down upon our own back areas swoop raiding enemy aircraft, tiny specks against the blue, travelling at 140 miles an hour—the most difficult targets in the world. But complicated instruments, designed by Ordnance, are sighted upon them, determining their altitude, speed, and direction, and taking into account the windage and the trajectory of the shell, predicting the exact positions of the planes when our antiaircraft artillery opens upon them. The slim barrels of a battery of antiaircraft guns, mounted on motor-trucks for mobility, are raised to the indicated elevation, and a salvo of shell goes whining skyward, each projectile fitted with a special fuse so delicate in action that contact with the thin fabric of an airplane's wing is sufficient to explode it, and yet so designed that it will not explode if, in loading, it should be accidentally dropped upon the ground. Ordnance again.

Night falls. The guns are silent. From along the line of the captured positions rise fireworks like those which delight the summer multitudes at Coney Island. Star-shell, fired from Veriy pistols, make graceful fiery arcs against the purple-velvet sky, bursting, as they descend, into fountains of sparks which illumine the positions where the weary Germans are. A night-bombing plane, prowling above the enemy's lines, unable to see its target in the darkness, releases a parachute-flare which slowly sinks earthward, illuminating the ground for a radius of a mile as brilliantly as though it were day. From the American positions colored signal stars—red, green, white, or "caterpillar" combinations—fall slowly across the sky, conveying all sorts of

cryptic messages to regimental and brigade headquarters in the rear, to the aircraft circling above, or to the patrols scouting in No Man's Land. All these pyrotechnics were designed and made by Ordnance.

But the work of Ordnance does not end when the guns cease firing. Far from it. The wear of battle on weapons of all kinds is enormous: guns must be relined and fitted with new recoil mechanisms; shattered wheels and trails must be replaced; broken rifles, pistols, bayonets, machine-guns, scabbards, helmets, trench-knives, periscopes, caissons, limbers, tractors, trucks, tanks, must be collected and transported to the rear for repair or salvage. For the maintenance of its material Army Ordnance had in the field many special facilities: mobile repair-shops, miniature machine-shops mounted on trucks to accompany each division; semiheavy repair-shops mounted on five-ton trailers to accompany each corps; heavy semipermanent repair-shops for each army; railway repair-shops for the railway artillery, each successively less mobile but of greater capacity. In addition to this vast equipment for repair work in the field there were the complete expeditionary base repair-shops, requiring for their operation a personnel three times as large as the peace-time organizations of all the arsenals in the United States put together, capable of repairing each month 2,000 pistols, 7,000 machine-guns, 50,000 rifles, of overhauling 2,000 motor-vehicles, and of relining a thousand cannon. Ordnance once more.

And back of all this was the mammoth organiza-

tion created by Army Ordnance in America itself: arsenals, gun-foundries, rifle and revolver factories, wagon-plants, ammunition-plants, nitrate-plants, silk-mills, tanneries, harness and leather-goods factories, 8,000 manufacturing plants in all, in which nearly 4,000,000 workers toiled day and night to produce the 100,000 separate Ordnance items required by our armies oversea. Beyond the activities that I have just sketched, the Ordnance Department didn't do much in the war.

Now it must be kept constantly in mind that the Ordnance problem with which America was confronted upon her entry into the war was essentially a non-commercial one. By that I mean that the articles required by the Ordnance Department had an extremely restricted use, in many cases, indeed, no use at all, in the commercial life of the nation. In the piping times of peace what use did we have for field-guns, howitzers, machine-guns, automatic rifles, anti-aircraft and railway artillery, shell, caissons, limbers, synchronizing devices, steel helmets, trench-mortars, periscopes, tanks, tracer, armor-piercing, and incendiary ammunition? Unlike the nations of continental Europe, we not only did not believe in war or anticipate war, but we deliberately blinded ourselves to the possibility of becoming involved in war, so that we were, consequently, wholly unprepared for war when it came. Hence, having no use for the tools of war in the pursuits of peace, we had little, if any, knowledge of how to manufacture them. The Euro-

pean Powers, on the other hand, having for centuries sat on a powder-magazine which, as they perfectly realized, might blow up at any moment, had prepared themselves to meet the conditions which would inevitably result from such an explosion by giving government support to private industry in the manufacture of war material. Thus were developed such vast ordnance industries as Krupp in Germany, Schneider-Creusot in France, Skoda in Austria, Ansaldo in Italy, which, though operating as private firms in time of peace, were always under government supervision, and automatically passed into government control in time of war. But even the great armaments maintained by Germany could not utilize in peace-time the enormous volume of war material produced at Essen. Yet it was imperative that the huge organization should be kept intact and ready for the war which would one day come. In order to maintain its organization and, so far as possible, its output, Krupp's was encouraged, therefore, to seek foreign markets for its surplus products, Germany's diplomatic, consular, and commercial representatives virtually becoming Krupp sales-agents in every corner of the globe. Thus it came about that wherever there was a promise of fighting, whether in China, in Mexico, in Abyssinia, in Venezuela, or in the Balkans, war material bearing the trade-mark of the great ironmaster of Essen was found in the hands of the prospective belligerents. If they could not pay cash, they were given credit, often long credit, and, when they did not possess credit, they usually were given the arms anyway. In this manner

the German ordnance-machine was kept oiled and active, largely by foreign money, against the day when Germany would have need for its maximum output herself. Thus the government at Berlin had at hand, in time of peace, a tremendous and highly trained industrial organization which fitted neatly into the German war-machine in time of war. The same was true, though in lesser measure, of the great French, Italian, and Austrian ordnance concerns. We in the United States, however, had nothing of the sort. The Bethlehem Steel Company manufactured a limited amount of artillery, it is true, and the Colt, Winchester, Savage, and Remington corporations manufactured small arms, though mainly for sporting purposes, but they made them without any hope of government encouragement or co-operation, and they marketed them in foreign countries without any save the most casual assistance from our diplomatic and consular officials. In certain cases, indeed, the government actively discouraged American arms manufacturers from disposing of their wares to foreign belligerents.

By the assurance of steady employment and lucrative remuneration the great European ordnance manufacturers attracted to their employ men of exceptional technical ability, thus forming a large and highly trained personnel with long experience in manufacturing the tools of war. The traditional policy of the United States, on the contrary, was to maintain in government employ a small, a very small, group of technically trained officers who, according to our careless American theory, would be able to design and

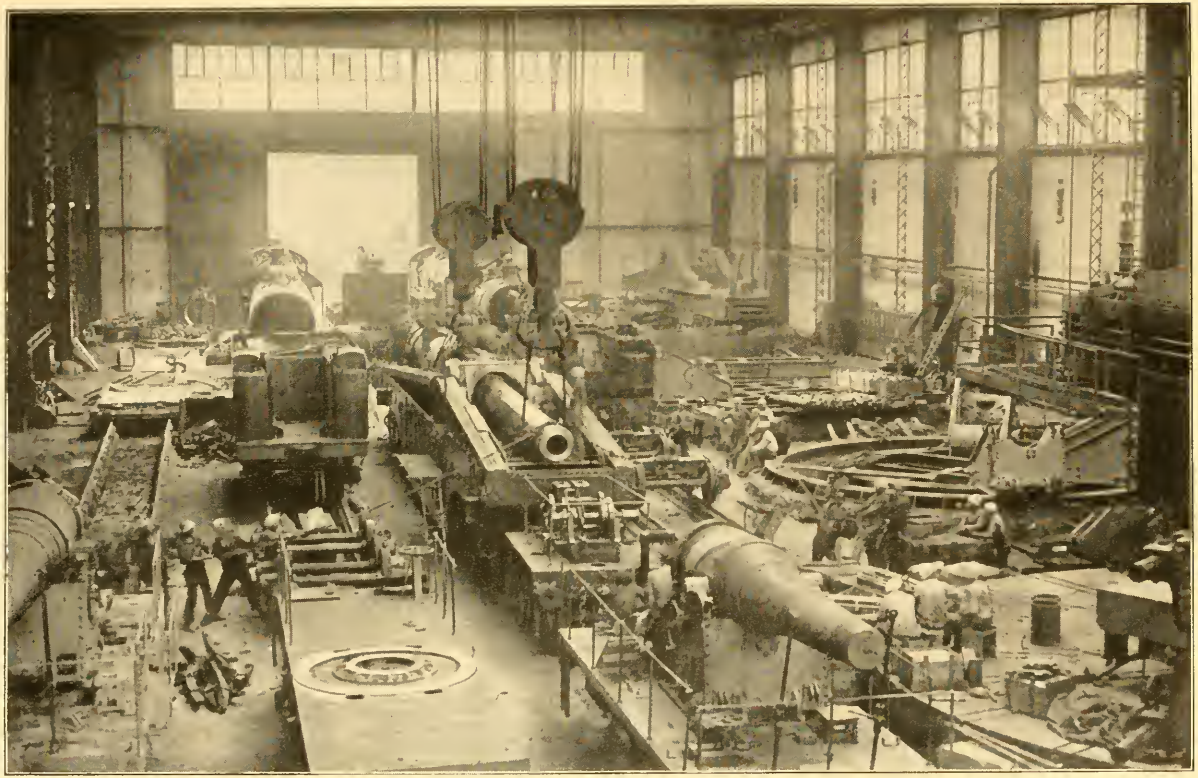
produce enough ordnance to meet the needs of our army in the remote and unlikely contingency that we should ever become involved in war. How ridiculously inadequate was this personnel will be realized when I say that there were but ninety-seven officers in the Ordnance Department at the outbreak of the war. How enormous were the requirements of the suddenly embattled nation is strikingly emphasized by the fact that 11,000 Ordnance officers were required for our first 5,000,000 men. All other branches of the service underwent similar expansion to a greater or less extent, it is true, but whereas Signal Corps officers could be recruited from the telegraph and telephone companies, Motor Transport officers from the automobile industry, Railway Transport officers from the great railway systems, Medical officers from the ranks of the country's surgeons and physicians, Engineer officers from the various branches of the engineering profession, Quartermaster officers from the packing and produce concerns, the clothing manufacturers, and the building trades, paymasters from the banks and financial institutions, judge-advocates from the members of the bar, there was no field of American endeavor to which the War Department could turn for officers trained in the highly technical and specialized profession of ordnance design and manufacture. How could there be? There had never been any demand for tanks, for trench-mortars, for airplane drop-bombs. Ergo, there was no one in this country who possessed other than a vague and theoretical knowledge of how to design or manufacture them. Therefore, we had to

set about training men to do these things. And we could not train these men in a week or a month. Ordnance designing, remember, requires the very highest form of mechanical and chemical engineering skill; its production is a highly specialized industry. A knowledge of its requirements was confined, as I have explained, to the ninety-seven Ordnance officers of the regular establishment and to a handful of highly salaried experts in the employ of certain private plants; the facilities for its production were limited to six government arsenals and to two large private concerns. The initial problem of Army Ordnance, therefore, was to disseminate on a nation-wide scale the special knowledge possessed by this handful of officers and experts and the special facilities possessed by these few arsenals and factories. In our endeavor to acquaint the nation with the requirements of the Ordnance Department we naturally turned to our Allies, who freely placed at our disposal the great volume of special data on the subject which they had collected during three years of war and which had resulted from the many costly experiments and investigations which they had conducted prior to the war—plans, specifications, working models, secret devices, jealously guarded formulas, even complete manufacturing processes. But, even with this great mass of detailed knowledge at our disposal, its translation into terms comprehensible to American engineers and practicable for American manufacturers was in itself a perplexing problem. The chief obstacles to our use of foreign designs, specifications, and formulas lay, in the case

of French and Italian designs, in the fact that they were written in different languages and expressed in different units of measurement, the principal difficulty involved in the adoption of English ideas being the radical differences in the manufacturing practices of the two nations.

During the early days of the war it was repeatedly charged, both on the floors of both houses of Congress and in the editorial columns of newspapers and magazines, that, owing to a breakdown of the Ordnance Department, we were compelled to beg from our Allies war material which they could ill afford to spare. Let it be clear that I hold no brief for the Ordnance Department, but, in view of the wide circulation given to these unfounded assertions, I would like to disprove them by quotations from two official communications. The first is a telegram from the mission, headed by Colonel E. M. House and including Admiral Benson of the navy and General Tasker H. Bliss of the army, which was sent to Europe in the fall of 1917 for the purpose of ascertaining how the American Expeditionary Forces could most quickly be rendered effective. It reads:

"The representatives of Great Britain and France state that their production of artillery, field, medium, and heavy, is now established on so large a scale that they are able to equip complete all American divisions as they arrive in France during the year 1918 with the best make of British and French guns and howitzers. With a view, therefore, to expediting and facilitating the equipment of the American armies in France, and,



A SCENE IN AN AMERICAN ARSENAL.

The Ordnance Department effected the most complete mobilization of science and industry the world has ever seen.

FILLING A POWDER-BAG FOR A 16-INCH GUN.

second, securing the maximum ultimate development of the munitions supply with the minimum strain upon available tonnage, the representatives of Great Britain and France propose that the field, medium, and heavy artillery be supplied during 1918, and as long as may be convenient, from British and French gun factories."

These offers were, of course, predicated on our continuing to furnish all raw material, all rough-machined forgings, and all finished components in quantities at least equal to those which we had been shipping to our allies since our entry into the war for finishing or assembly abroad. By our acceptance of these offers we not only obtained a breathing spell which enabled us to plan an ordnance programme which would insure the maximum production of artillery and artillery ammunition by the close of 1918, but the new arrangement, coming into effect at a period when the submarine sinkings were at their height, insured us against the possible loss of the raw material only and not also the time and labor which we would have had to put into the finished article. In other words, by this co-operative arrangement we increased our production to the maximum and reduced our possible losses to the minimum. How the French regarded this arrangement is shown by the words of M. André Tardieu, then French High Commissioner in the United States:

"From the industrial view-point the unity of effort created will produce happy results without precedent. From the financial standpoint it is possible to hope that the purchase by the United States of French artil-

lery material will create an improvement in exchange, much to be desired. From the military point of view it is evident that uniformity of type of guns and munitions for armies fighting on the same battle-fields is an appreciable guarantee of efficiency."

The adoption for our own manufacturing programme of the British types of heavy howitzers entailed no unusual complication, but the adoption of the French types of field-guns and light howitzers introduced a factor whose importance the lay mind had theretofore not fully realized. I refer to the French use of the metric system, in which, of course, all the plans, specifications, and drawings furnished us by the French were figured. One inch = 2.54001 centimetres. The full significance of this difference in the national units of measurement is not apparent until one reflects that not a single standard American drill, reamer, tap, or die will accurately produce the results demanded by the specifications on a French drawing. Furthermore, the French standards for bar stock, for rolled sheets and plates, for structural steel shapes such as angles and I-beams, even for rivet-holes and rivet spacing, are far different from American standards. Given complete, up-to-date drawings of French material (and in many cases these were not obtainable), the Ordnance engineer was immediately confronted with the necessity of either changing the American shop equipment —drills, reamers, taps, dies, and the like—to conform with French standards of measurement, thereby discarding the advantage of quick procurement of standard rolled stock, bolts, nuts, rivets, cotter-pins, or of

doing what he did do—translating the centimetres in which the French specifications were figured into inches. But this was by no means all. French industrial practice develops the highly skilled all-round machinist to whom is left considerable discretion in determining finished dimensions and in fitting assembled parts; American industrial practice develops the machine specialist who works to tolerances—to maximum and minimum gauges—and whose output accordingly requires little or no hand-fitting of assembled parts. The French mechanic always sees the complete assembled unit; the American confines his attention to the particular component on which he is engaged and the gauges which check the accuracy of his work. So, in translating the French drawings, they had to be adapted not only to the material phase of American shop practice, but the personal equation of the American workman had also to be considered. Tolerances had to be prescribed, limit gauges had to be provided, jigs and fixtures, special milling cutters, and a hundred other tools and instruments had to be designed and manufactured. But our manufacturing difficulties did not end even there. Though the French gave us the drawings of even their most jealously guarded secret devices, they could not give us that intangible something which, for want of a better term, I can best describe as innate mechanical skill of so high an order that it approaches genius, which is so marked a characteristic of the best French artisans and mechanics. Take, for example, the problem involved in the manufacture of the hydropneumatic recuperator for absorb-

ing the shock of recoil when a gun is fired—the recoil mechanism, as it is commonly called. This marvellous device performs a task equivalent to quietly halting the flight of a shell from a 75-mm. field-gun before it has travelled forty inches from the muzzle. So intricate is the mechanism, so delicately adjusted, that although it was introduced twenty years ago, it had never until recently been successfully manufactured outside of France. Though the Germans captured hundreds of these famous guns, the combined engineering skill of Krupp's, with the model before them, was never able to manufacture a single one.

The inherent difficulties encountered in producing these new types of ordnance, great as they were, were dwarfed, however, by the vastness and variety of the quantities involved. Let me see if I can make this clear. Compare the question of ordnance supply with that of subsistence, for example. A man eats no more in time of war than he does in peace. Speaking roughly, it is fifty times as difficult to feed 5,000,000 men as it is to feed 100,000 men, whether the smaller force represents peace conditions and the larger one war conditions, or not. Consequently, the strain thrown upon the organization charged with the feeding of the army increased only in direct numerical proportion to the strength of the army. But, though war did not increase the demand of the individual infantryman for food, it enormously increased his demand for small-arms ammunition. Before the war each infantryman in the United States Army required 276 cartridges a year; during the war this jumped to 2,372 cartridges,

an increase of 1,040 per cent. In peace-time each machine-gun used approximately 6,000 rounds of ammunition; after the declaration of hostilities each of these voracious little weapons required 228,875 rounds —an increase of 4,600 per cent. Likewise, the needs of the 3-inch field-guns increased 18,200 per cent and those for 6-inch guns 73,400 per cent over their peace-time requirements. Here is another way of stating the same thing. If a pound of bread a day satisfies a man's appetite in time of peace, a pound of bread per day will satisfy it in time of war; but if a pound of metal represented the ordnance which he required in time of peace, from 10 to 700 pounds of metal would represent the ordnance which he will require upon going to war.

The constantly increasing tendency toward employing mechanical and chemical means of warfare produced another difficulty. Before the United States entered the war, a total of 50 machine-guns was the standard equipment of an infantry division. But when the Armistice was signed the tables of organization gave each division 768 automatic rifles and 262 machine-guns, an increase in this type of equipment of more than 2,000 per cent. Furthermore, the General Staff of the A. E. F. was working on plans for the reorganization of infantry units which would have increased the number of automatic rifles in each company to 24—approximately one for every ten men— and which would have established a new equipment of 192 automatic rifles for each artillery brigade. It is scarcely necessary to point out that every additional

automatic arm, with its insatiable appetite for cartridges, necessitated a corresponding increase in the requirements for ammunition and for ammunition supply.

Before the United States entered the war, practically all field-artillery, including guns, howitzers, limbers, caissons, repair-wagons, and the like, was drawn by horses or mules, the Ordnance Department furnishing the harness and other horse equipment. The difficulty in obtaining an adequate supply of animals, however, together with the high rate of animal mortality, the constantly increasing weight of the guns, and the nature of the terrain, made necessary the wholesale motorization of the artillery, which was proceeding at an amazing rate when hostilities ended. Guns are now hauled by tractors; caissons and limbers have been displaced by motor ammunition-trucks; complete machine-shops, mounted on motor-trucks, supplant the old forge-limbers and battery and store wagons; machine-guns, instead of being packed on mules or drawn by horses, are usually moved to the front by various forms of motor transport and are often taken into action in tanks. Even the large-calibre field-pieces are now mounted on caterpillar tractors, which not only provide means of transportation for the guns but also the means for aiming them. These changes naturally brought others in their wake. The higher speed of motor-drawn artillery demanded rubber-tired wheels. The substitution of the automatic rifle, with its terrific burst of fire, for the ordinary shoulder rifle, entailed a tremendous increase in the capacity of the ammuni-

tion-trains. So, as the tools of war became more mechanically efficient, they became correspondingly more complicated to manufacture.

Now there were no limitations imposed as to where these tools should be procured. No one but a fool or an ignoramus would have insisted that, engaged as we were in a life-and-death struggle with a savage and ruthless enemy, we should only procure the weapons with which to subdue that enemy within our own borders. If there is a marauder in your grounds, your chief concern is to get a gun; you do not particularly care whether it is your own gun or one loaned you by a neighbor, so long as it will shoot and shoot straight. The problem of the Ordnance Department, then, was to procure arms for our armies, to procure them in sufficient quantities, and to procure them quickly—*not to procure them in America only.* To have set any such limitations on our effort, no matter how flattering it might have been to national pride, would have cost untold lives, it would have greatly prolonged the war, and it might well have produced a different and far less happy result. So, because our allies were both able and glad to supply us from their surplus store, and because it was the only way that we could obtain immediate delivery of certain things without which our armies could not fight, we purchased artillery abroad, as well as ammunition for that artillery; we also purchased airplanes, automatic rifles, clothing, food, surgical instruments, medicinal supplies; we sent our forestry battalions into the French forests for lumber—they produced 50,000,000 feet in the

month of October, 1917, alone; we quarried their stone to build our roads; we drew on their reservoirs for water—all highly proper courses of action, adopted with the fullest approval of France and England, and, indeed, at their express suggestion, for the purpose of utilizing the available ship tonnage of the world to the best and quickest advantage in effecting the defeat of our common enemy. Critics have brought the charge that we purchased ordnance from our allies, intimating that it was a scandalous proceeding for which the Ordnance Department should hang its head in shame. Yet I do not recall that those critics ever completed the story by stating that we sold to our allies ordnance and raw materials for ordnance to a value *five times greater than our purchases from them.*

But even with free access to and unlimited credit in the markets of the world, grave questions of priority had to be decided; the impending exhaustion of the world's resources in certain raw materials and certain classes of skilled labor demanded constantly increasing consideration. It was of paramount importance, of course, that our own preparations for war should not in the slightest degree delay or lessen the assistance which we had been rendering our allies, and which they had come to regard as perhaps the most important factor in calculating their ability to hold the enemy in check until our military effort could become effective. Furthermore, there had to be taken into consideration the demands of the American Navy, which required heavy forgings and other material, as well as trained labor, of the very type so necessary for the solution of

the army ordnance problem. On the assumption that it would be of little avail to build ordnance for use in the field in France unless there were cargo-ships in which to transport it and war-ships to protect those cargo-boats against submarine attack, the requirements of army ordnance were made secondary to the demands of our allies, of our navy, and of our merchant marine.

The supreme difficulty encountered in the solution of the ordnance problem is best stated in the words of the Honorable Winston Churchill, then British Minister of Munitions, in his report to the British War Council for the year 1917:

"In the fourth year of the war we are no longer tapping the stored-up resources of national industry or mobilizing them and applying them for the first time to war. The magnitude of the effort and of achievement approximates continually to the limits of possibility. Already in many directions the frontiers are in sight. It is therefore not necessary merely to expand, but to go back over the ground already covered and by more economical processes, by closer organization, and by thrifty and harmonious methods to glean and gather a further reinforcement of war power."

The situation in which the British found themselves in 1917, the critical year of the war, as depicted by Mr. Churchill, was also, though to an even greater degree, the situation of the French, and, to a lesser degree, our own. Due to the gradual but increasing exhaustion of the world's resources of raw material

and skilled labor, the production of ordnance, at first merely a manufacturing problem, became more and more, as the limit of expansion was produced, a problem of securing raw materials, skilled labor, and transportation. The cumulative effect of the difficulties which I have enumerated produced a task of such magnitude as to be literally beyond the conception of the human mind. It involved the mobilization of science and industry and their co-ordination with the military establishment to an extent approaching the limits of human endeavor. Indeed, I am indulging in no mere peroration, no idle figure of speech, when I assert that the Army Ordnance effort represented the application of a greater physical effort than was ever directed toward the accomplishment of a single purpose in the history of mankind.

Just as a track meet consists of various events—dashes, distance runs, broad jumps, high jumps, shot-putting, and pole-vaults—so there were numerous elements comprised in the ordnance problem. For Army Ordnance, the declaration of war was the starter's pistol; the meeting of requirements by actual deliveries the goal. In estimating any accomplishment, whether it be the time in which a sprinter runs a hundred yards or a horse trots a mile, the altitude reached by an aviator or the speed of a transatlantic liner, it is necessary to take some accomplishment along the same or similar lines as a standard of comparison. It is generally admitted by athletes, for example, that for a man to run a hundred yards in ten seconds is an excellent performance; for him to run the same

distance in nine seconds would be amazing. If, in view of this generally accepted standard of what constitutes a sprinter's utmost exertion, a critic condemned a sprinter for not running a hundred yards in eight seconds, or in seven seconds, that critic would be branded by all intelligent persons as lacking in knowledge and judgment. So, in criticising the degree of success attained by the Ordnance Department during the war, it would be well for the critics to be quite certain that they have chosen just standards of comparison, and that they possess a sufficient knowledge of the problems involved in ordnance production to enable them to recognize a record-breaking performance if they saw one.

Generally speaking, it may be said that those phases of the ordnance programme which had the shorter time limits were unqualifiedly successful. There was never a time when the production of smokeless powder and high explosives did not equal our own requirements and still leave us with a surplus sufficient to provide large quantities for both France and England.

During the nineteen months of our participation in the war we produced over 2,500,000 rifles, a quantity greater than that produced during the same period by France (1,400,000) or by England (1,970,000), and this notwithstanding our handicap of a standing start. To use a fairer method of comparison, the average monthly production of France during July, August, and September, 1918, was 40,500; of England, 112,821; of the United States, 233,562. In other words, to again make

use of the athletic simile, not only did America cover a greater total distance during the same period of time, but when the race was called off by the signing of the Armistice we were producing rifles at a rate double that of England and five times that of France.

Of small-arms ammunition (for pistols, rifles, and machine-guns) there were produced between April 6, 1917, and November 11, 1918, 2,879,148,000 rounds, a total equivalent to three cartridges for every minute which has elapsed since the beginning of the Christian era! True, this total fell slightly below that of England (3,486,127,000) and of France (2,983,675,000) for the same period, but it must be remembered that those nations had developed highly efficient manufacturing methods as the result of the experience they had gained during their nearly three years of war prior to our entry into the conflict. Notwithstanding their running start, before the Armistice we attained a speed in the manufacture of small-arms ammunition double that of France and 10 per cent greater than England's.

During that period that we were at war we produced 181,662 machine-guns, a total slightly greater than that of England (181,404) and slightly less than that of France (229,238), but here again a comparison of total production is hardly a fair statement of relative accomplishment, for in machine-gun manufacture an enormous length of time is required to build factories, to equip them with machine tools, to design the necessary jigs, fixtures, dies, millers, profiles, and the innumerable limit gauges for testing the precision of the various parts. A fairer basis of comparison—the

average monthly rate of production during the months immediately preceding the signing of the Armistice—shows that America was producing 27,270 machine-guns and automatic rifles a month—more than twice as many as France and nearly three times as many as England.

As to artillery ammunition, let us take the production of shell for the 75-mm. guns. Of this calibre we had produced 4,250,000 high-explosive shell, more than 500,000 gas-shell, and over 7,250,000 shrapnel when the Armistice was signed. From January 18, 1918, when the first complete American division entered the line, until firing ceased ten months later, our gunners used 6,250,000 rounds of 75-mm. ammunition. Prior to the Armistice we had shipped to France about 8,500,000 shell of this same calibre. Thus it will be seen that though American gunners admittedly made use of French-made ammunition from the Franco-American pool (thereby confirming the worst suspicions of the army's critics), each round fired was made good prior to the signing of the Armistice with 33⅓ per cent margin.

Of the artillery programme proper, it is difficult to appraise the performance, for the reason that the race was called off before it was half run. It will be forever difficult to establish beyond question whether the American artillery programme at the time of the signing of the Armistice was as sufficiently far advanced as could be reasonably expected under the circumstances. Any attempt to pass on Ordnance's accomplishment, or lack of accomplishment, in this respect

must in justice take into account the best previous performance along these lines. Of all the countries engaged in the war the experience of England affords the closest parallel to that of the United States in respect to the initial stages of industrial and military preparation. In determining a standard of performance in the equipping with artillery of a hastily raised army by a peace-loving nation, permit me to quote a few significant sentences from a statement made by the British Ministry of Munitions:

"It is very difficult to say how long it was before the British Army was thoroughly equipped with artillery and ammunition. The ultimate size of the army aimed at was continually increased during the first three years of the war, so that the ordnance requirements were continually increasing. It is probably true to say that the equipment of the Army as planned in the early summer of 1915 was completed by September, 1916. As a result, however, of the battle of Verdun and the early stages of the battle of the Somme, a great change was made in the standard of equipment per division of the Army, followed by further increases in September, 1916. The Army was not completely equipped on this new scale until spring, 1918."

Thus it will be seen that it took England nearly four years to completely equip her army with artillery and ammunition. On that basis we had two years and five months to go before incomplete equipment with American-made artillery could have been condemned, with justification, as poor performance. The

nineteen months which the war lasted after America's entry did not give sufficient time for our industrial power to make itself fully felt. Even so, I don't suppose that any one, save perhaps the profiteers, would wish the war to have lasted long enough for us to prove that we could produce artillery as rapidly as our allies.

It should be kept in mind that proper strategy demanded an ordnance programme designed to insure an *ultimate* overwhelming and continuous rate of production rather than a lesser rate of production at an earlier date. What I wish to get across to you (pardon the slang) is that the primary object of Ordnance was not to obtain immediate production of enough artillery and ammunition to equip our little First Contingent, but to obtain a *rate of production* which would provide for the equipment of the army of 5,000,000 men which it had been decided to raise. Now it is perfectly obvious to any one that a housewife could buy a stove and bake a dozen loaves of bread in far less time than would be required to build a bakery and bake enough bread to feed an entire city. But the rate of production from the housewife's oven would never feed the city. So it was with ordnance. By the sacrifice of far more important considerations, there is no doubt that enough guns could have been produced in a comparatively short time to equip the first few divisions. In order to do this, time was required for building plants capable of such a rate of production. We had to obtain designs and even, in certain cases, to discard existing designs, in order to get manu-

facturing plants on a basis permitting such a rate of production. It would have been madness to have sacrificed production in 1920 to force a quicker but far smaller production in 1918. The Ordnance Department was not directing its efforts to obtain for American arms an immediate but isolated success, gratifying as such a success would have been to American pride; instead it was building a machine which would make an ultimate and sweeping victory absolutely certain.

No branch of the army took up its war-task under such discouraging conditions as the Ordnance Department. It had 97 officers; it needed 10,000. But where were they to come from? It was and is impossible to improvise ordnance experts, like those of pre-war times, who were required to possess a thorough knowledge of all phases of ordnance work from design and development through procurement, production, and inspection to the supply of troops. But upon the outbreak of hositilities thousands of engineers, graduates of the world's most famous technical institutions and many of them with wide experience in their respective branches of the engineering profession, offered their services to the Ordnance Department, and it is very largely due to their ability, experience, and devotion that the solution of many of Ordnance's most perplexing problems is due. The industrial field, too, yielded a generous contribution of its best ability. To these men were often given strange tasks. They were called upon to procure materials with which they were unfamiliar in markets where no readily available supply existed. They had to design and erect complete manufacturing plants and to teach manufactur-

ing methods which they themselves often had first to learn. Time after time they were ordered to manufacture articles of which they had never so much as seen a specimen before they entered the army. A huge personnel had to be organized to care for the inspection of this enormous volume of varied material, to prove it by means of firing tests at Aberdeen and elsewhere, and to develop it from the first rough model through all the interminable stages to the point of successful quantity production.

The advice, wishes, and requirements of our allies were given full consideration, often at a sacrifice of natural national pride. On their advice or at their formally expressed desire, we in many cases undertook the manufacture of components instead of complete assembled units: powder for propelling charges and high explosives for bursting charges of ammunition, instead of assembled shell complete in smaller quantity; black or rough-machined forgings for cannon, projectiles or recuperators in place of the corresponding finished articles; motors and structural steel work for standardized tanks for joint use in lieu of a smaller number of complete units for the use of our armies alone. We yielded priority on raw material sorely needed to make our own programme a success, but even more desperately needed by our allies to stave off defeat until we should arrive in force.

Every 15 pounds of finished smokeless powder requires 14 pounds of cotton and 700 pounds of mixed acid for its nitration, so we made the gun-cotton to the extent of more than 500,000,000 pounds on this side of the water, thus saving the excess tonnage that

would have been required for the shipment of the raw materials. A similar condition obtained with regard to high explosives. Guided by the same sound principle, we shipped in bulk enough pierced shell blanks to keep the French and British factories going to the limit of their capacity, and so on through the endless list of articles or components required for our common use. For, be it remembered, it was not our war alone.

The quality of our product is attested by the almost pathetic eagerness of the *poilu* to acquire an American rifle with its beautifully adjusted sights, its admirable breech mechanism, and its rimless, non-jamming ammunition; by the universally acknowledged excellence of the American automatic pistol; by the purchase by the French Government of 550 155-mm. howitzers built in America from French designs; by the cabled request of the French Government for a continuous supply of 3,000 Browning machine-guns *every month* and 50,000,000 cartridges for them, after witnessing their performance under battle conditions; by the general order from British General Headquarters directing that on account of its greater uniformity, and consequent less danger to the troops advancing under its protection, *only American-made powder* be used for artillery barrages—all these are tributes to American science, American engineering, and American industry, as exemplified in American ordnance, by qualified judges who were backing their opinions with their lives.

American artillery may be roughly divided into four classes: light, medium, heavy, and railway. The

Photograph by Signal Corps, U. S. A.

AN AMERICAN 75-MM. IN ACTION.

The French admitted that the 75-mm. field gun as built in the United States in several respects excelled their own famous Soixante-Quinze.

THE 37-MM. GUN IN ACTION.

This vicious, hard-hitting, and extremely mobile little weapon proved of enormous value in wiping out machine-gun nests.

light artillery consists of two types: the little, hard-hitting 37-mm. infantry-accompanying cannon, operated by two men, primarily designed for knocking out "pill-boxes" and machine-gun nests and, with a shortened barrel, for use in tanks, and the 75-mm. field-gun, an American adaptation of the famous French *soixante-quinze*, which, according to the admission of the French themselves, it in several respects excelled. Three types of weapons are included in the medium-calibre class: the 4.7-inch field-gun, which we had adopted and had manufactured in small quantities prior to our entrance into the war; the 155-mm. G. P. F. (*Grand Puissance Filloux*), really a big brother of the "seventy-five," with correspondingly increased power and range, designed for interdicting crossroads and harassing the enemy's middle areas, and the 155-mm. howitzer, which with its plunging fire is admirably adapted for trench and dugout demolition. In mobile heavy artillery we have the 8-inch and 9.2-inch howitzers, likewise designed primarily for demolition purposes. And, finally, the great 8, 10, 12, 14, and 16 inch pieces—guns, howitzers, and mortars—mounted on and fired from specially designed railway-trucks suited to the French road-beds—for incessant pounding of the depots, dumps, headquarters, and railways far behind the enemy's lines. In addition to the above there are, of course, the various types of antiaircraft artillery, mainly of 75-mm. calibre, and the trench-mortars, ranging in size from the 3-inch Stokes, light enough to go over the top with the first wave of an attack and simple enough to be fired when supported only by the knees of a squat-

ting soldier, up to the 240-mm. trench-mortar of position, whose great shell can blow the stoutest concrete fortification to smithereens. We also had in use at various times small numbers of miscellaneous calibres and types, but, as the result of the policy of reducing the number of types in order to simplify the problem of ammunition supply, our artillery had become fairly well standardized by the closing months of the war.

Years ago—though not nearly so long ago as it seems—when artillery was still hauled into position by sweating gun-teams, a veteran ordnance officer, addressing a scientific society, told his hearers that the weight of artillery was governed by the limited power of the horse. As a horse has a sustained pulling power of only 650 pounds, he explained, it was obvious that a 6-horse gun-team could not pull a gun and limber weighing more than 3,900 pounds. "If Divine Providence had given the horse the speed of the deer and the power of an elephant," he added, "we might have had a far wider and more effective range for our mobile artillery." Could that officer have looked a few years into the future he would have been astonished to see that, thanks largely to the genius of a Californian named Holt, there would be substituted for the horse a curious contrivance known as the caterpillar tractor, which possesses many times the power of an elephant. Though the tractor cannot be claimed, by any stretch of the imagination, to have the speed of a deer, it nevertheless has sufficient speed to keep pace with the infantry, or, indeed, should it become necessary, with cavalry. Few people appear to realize how enormous were

AN AMERICAN 75-MM. FIELD GUN, TRACTOR MOUNTED.

Thanks largely to the genius of a Californian named Holt, there has been substituted for the horse a curious contrivance known as the caterpillar tractor which possesses many times the power of an elephant.

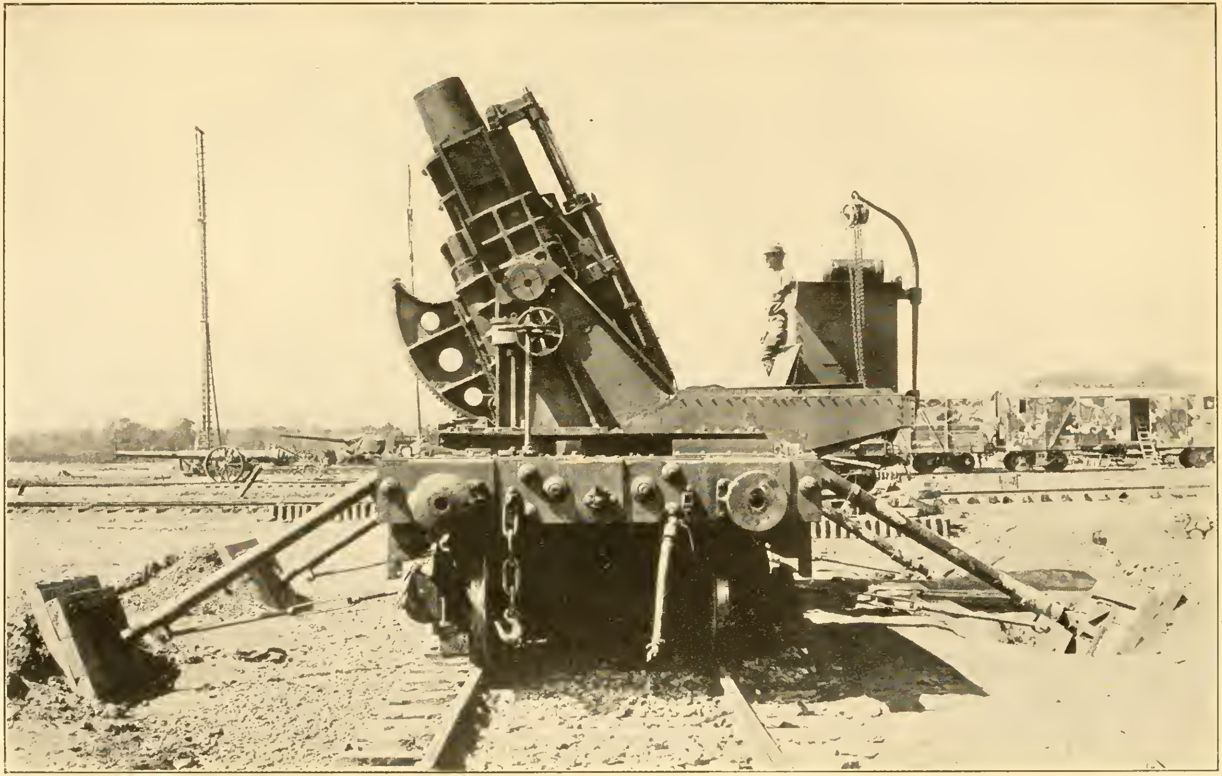
A 12-INCH RAILWAY GUN IN OPERATION.

Note the shell in flight.

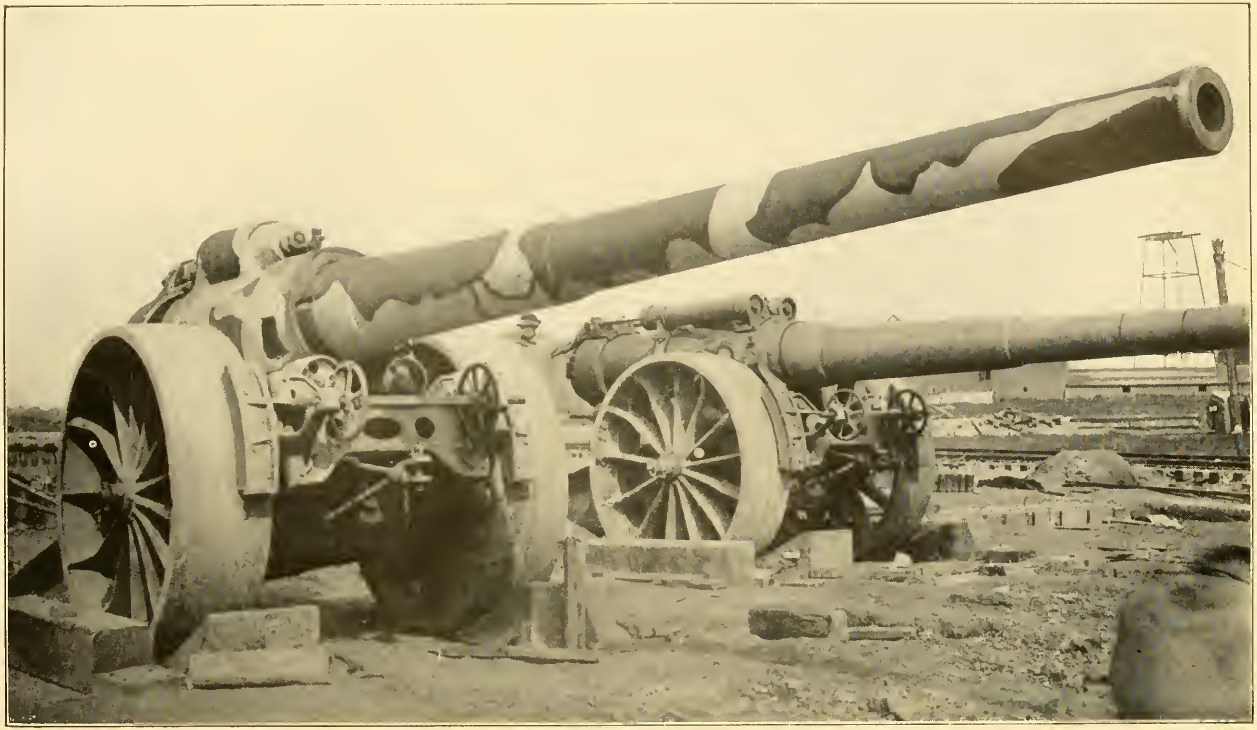
the savings in men, animals, feed, railway facilities, and ocean tonnage effected by the motorization of our artillery. The motorization of one 155-mm. howitzer regiment saved 1,440 horses. One tractor for this howitzer is the equivalent of sixteen heavy draft-horses and three riding-horses, yet it is so compact that it occupies in packing a space of but 360 cubic feet, and can be operated by two men. Tractors are not only easier to conceal from enemy observation than horses, but a shell-burst which would kill every horse in a battery, would leave an armored tractor uninjured. Not long ago, at the Aberdeen Proving-Ground, one of these tractors, on which was mounted an 8-inch howitzer, sent through a dense wood, ran squarely into a live locust-tree which was seventeen inches thick at the base. Before the onslaught of the tractor the tree went down as though it were made of cardboard, whereupon the amazing machine crawled over the fallen trunk, slid into and clambered out of a ravine, emerged from the wood and took up its firing position—all in scarcely more time than it takes to tell of it. Before the war ended virtually every piece of American medium and heavy artillery was either tractor-mounted or tractor-drawn, and we were on the road toward motorizing the field-artillery—the "seventy-fives"—as well.

But, though the General Staff of the A. E. F. demanded mobility for the artillery, it also demanded increased weight and range. To meet this requirement there were devised various types of railway-artillery, ranging in size from 7 to 16 inch, thereby making

available for use on the battle-front numerous guns from our seacoast fortifications which could not have been used otherwise. Early in the war the Army borrowed from the Navy a number of 7-inch naval rifles on pedestal mounts, for which the Ordnance Department provided specially designed gun-cars, thus affording a powerful and yet mobile form of defense for our coasts in the event of submarine attack. The next performance worthy of note was the mounting on railway-cars of ninety-six 8-inch guns taken from various seacoast fortifications. Both of the above types of gun, as well as the 12-inch mortars, were mounted on the so-called Barbette carriage, which permits of all-round fire at any desired elevation. The 10-inch seacoast rifle and all sizes above it were mounted on the Batignolles type of carriage, which depends primarily on the track arrangement for its direction of fire. Both the Barbette and Batignolles mounts had, after the initial setting, all the characteristics of fixed emplacements, but with the added advantage of being able to advance or retire with a minimum loss of time. A third type of railway-mount, which was used very successfully by the French and which was being adapted for certain of our 10, 12, and 14 inch guns when the war ended, was the Schneider, or sliding type of mount. Though this mount also depends upon the track arrangement for its direction of fire, it has none of the features of a fixed emplacement, the force of the recoil being taken up by permitting the entire mount to slide back on the track during the recoil of the gun. The "Chilean project," as it was known, con-



A 12-INCH SEACOAST MORTAR ON A RAILWAY MOUNT.



6-INCH SEACOAST RIFLES TAKEN FROM COAST FORTIFICATIONS AND MOUNTED FOR FIELD USE IN FRANCE.

sisted in mounting six 12-inch guns, which had been manufactured in the United States for Chile and were on the point of delivery when they were commandeered by our government, on special sliding mounts designed by the Ordnance Department. Still another venture was the mounting for railway use of a number of 14-inch guns loaned by the Navy to the War Department. But the most ambitious project undertaken by Ordnance in connection with railway-artillery was the production of the huge 16-inch howitzer, to manufacture sixty-two of which an entirely new shop had to be erected by the Midvale Steel Company. This, the heaviest railway-mount of American design, weighs, with its gun, nearly a million pounds. The design and production of a device which would absorb its recoil of *seven million pounds* was in itself no inconsiderable engineering problem. Each of these monster railway-cannon has its own train, consisting of standard and narrow-gauge ammunition-cars, as well as cars for tools, for spare parts, for repair work, and for the crews. Huge as they are, rivalling in range and power anything which the Germans had at Metz or the British at Gibraltar, they are extremely mobile, any one of them being able to drop its load of high explosive far behind the enemy's lines, "pull stakes," and be miles away before the enemy could get its range.

Speaking of the range of artillery, some truly amazing results in this field were achieved by Major Forest Ray Moulton, one of America's foremost mathematicians, who was professor of astronomy in the University of Chicago before he was given a commis-

sion in the Engineering Division of Ordnance and turned his knowledge of ballistics to military account. One usually thinks of a professor of astronomy as a highly impractical person whose mind is absorbed in comets, meteors, and stars, yet no individual in the armies of the United States did as much as Doctor Moulton toward perfecting devices for killing Germans at long range. Here is a sample of his achievements. As the result of a series of abstruse calculations he made a change in the shape of the copper driving-band on the 6-inch shell, whereby, *without adding to the powder charge and with no modification whatever in the gun, he increased its range two and a half miles.* What is even more remarkable and important, he so reduced the variation between successive shots that a given number of shell will fall into one-eighth the area formerly covered by their dispersion. Had the war continued a year or so longer, there is no saying where Doctor Moulton's ballistic discoveries would have led. It was evidently of one of the shell designed by him that the negro soldier remarked:

"Ah could staht runnin' at brekfus'-time an' that theah shell 'ud git me jes' when Ah got home foah suppah."

Whereupon his companion exclaimed scornfully:

"All one of dem shells wants is jes' yo' address, niggah—jes' yo' address."

No phase of the Ordnance Department's work during the war came in for such severe criticism as the adoption and production of machine-guns. Now it so

happens that I am thoroughly familiar with the details of the long and bitter controversy which began with the original rejection by the Ordnance Department of the Lewis gun and which ended with the eventual adoption of the Browning. Many of the attacks made on the War Department by the supporters of Colonel Lewis, as well as in the editorial columns of the newspapers, were not justified by the facts and showed an incomplete knowledge of the circumstances, yet, as an impartial observer with some inside knowledge of the situation, I freely admit that for certain of the criticisms there was ample justification. Let me remind you, moreover, that the Lewis being considerably heavier than the Browning machine-rifle and much lighter than the Browning machine-gun, could not satisfactorily have taken the place of either. With which passing comment we will let the machine-gun controversy rest.

Machine-guns of the so-called heavy type had been developed to a serviceable stage at the time of the Spanish-American War, but neither then nor in subsequent conflicts did they receive anything like the attention which they attracted immediately after the outbreak of the war in Europe. The Germans had apparently realized better than any one else the value of machine-guns in the kind of fighting which they expected to be engaged in, having had, it is reported, 50,000 machine-guns when hostilities opened. American appreciation of the rôle destined to be played in warfare by machine-guns is best evidenced by the fact that, when we entered the war, our tables of

organization gave to each regiment four machine-guns!

When war was declared there were on hand in this country approximately 670 Benet-Mercie machine-rifles, 285 Maxim machine-guns, and 350 Lewis guns chambered for British ammunition. The machine-gun manufacturing facilities in the United States were also more limited than were the facilities for rifle manufacture, by reason of the fact that England and France had depended on their domestic resources to supply the bulk of their machine-guns. As a result there were only two plants in the United States which were actually producing machine-guns in quantity when hostilities began. Six days after our entry into the war the War Department ordered 1,300 Lewis guns (which order was subsequently increased) and, in June, 2,500 Colt guns, which were to be used for training purposes. The first division to be sent abroad was necessarily armed with the all-but-obsolete Benet-Mercie machine-rifle, but upon its arrival in France the French Government offered to equip the division with Hotchkiss machine-guns and Chauchat machine-rifles—the same automatic arms which the French had been using for three years. The offer was thankfully accepted, not only for the first division but for a number of succeeding divisions, thus insuring a supply of automatic weapons for our troops until we were in a position to supply them ourselves.

The result of a series of machine-gun tests held by a board appointed by the Secretary of War in May, 1917, proved conclusively that the gun invented by

John M. Browning, a Utah gunsmith who already possessed a wide reputation as an inventor of automatic weapons, was the best type of heavy machine-gun known to the board, and that the light automatic rifle, also an invention of Browning, was likewise the most efficient weapon of its type. The Lewis and the Vickers, both of which had been extensively used by the British since the opening days of the war, were also favorably reported upon and it was recommended that their manufacture be continued. Acting on the recommendation of the board, the Ordnance Department immediately increased its orders for Lewis guns, placed orders with the Colt's Patent Fire Arms Manufacturing Company for Browning machine-rifles and machine-guns, and began the development of large manufacturing facilities for the last-named types in order that the quantities required could be produced within the time specified. Although the Colt Company was the owner of an exclusive right to build machine-guns and automatic rifles under the Browning patents, the Ordnance Department early recognized that no single plant could hope to produce a sufficient number of these weapons to meet the constantly increasing requirements of our armies. Arrangements were therefore made with the Colt Company and with the inventor, Mr. Browning, for the surrender of their exclusive rights, the United States being granted authority to manufacture these weapons wherever it saw fit during the period of the war. As a result of this energetic, action, by the early part of 1918 the Savage Arms Company at Utica, New York, was producing

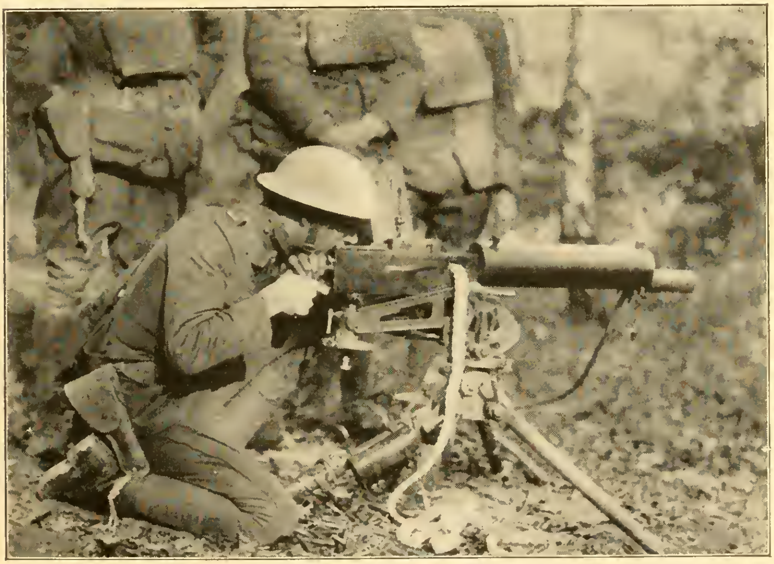
Lewis guns of the flexible type for use on aircraft (the large orders for Lewis ground guns having been diverted to aircraft use upon the cabled recommendation of General Pershing); the Marlin-Rockwell Corporation at New Haven was manufacturing large quantities of Marlin Aircraft machine-guns of the synchronized type; the Colt's Company was building Vickers machine-guns of the heavy mobile type, while various factories selected by the Ordnance Department because of their facilities were energetically tooling up for the immense production of Browning machine-guns and automatic rifles which later followed. Early in March, 1918, the Winchester Repeating Arms Company, to whom, as the result of the arrangement already referred to, the Browning plans and specifications had been turned over, produced the first Browning rifles, and two months later the New England Westinghouse Company turned out the first Browning machine-guns. When the Armistice was signed, the American Expeditionary Forces had been equipped with 41,348 Browning heavy machine-guns and 48,082 Browning rifles.

As the Marlin Aircraft machine-gun was available and was giving a considerable degree of satisfaction, no particular effort was made to push the development of the Browning Aircraft machine-gun, as it was feared that to do so might interfere with the production of the Browning machine-gun for ground use. Only a few hundred Browning Aircraft guns had, therefore, been produced up to the time of the Armistice. These had, however, been satisfactorily synchronized so as to

Photograph by Signal Corps, U. S. A.

JOHN M. BROWNING, THE INVENTOR OF THE PISTOL, RIFLE, AND MACHINE GUN WHICH BEARS HIS NAME.

Mr. Browning is holding the automatic rifle which he invented.



Photograph by Signal Corps, U. S. A.

THE BROWNING HEAVY MACHINE GUN.

This, the deadliest weapon of the war, can fire at the rate of 1,000 shots a minute.

A RIFLE GRENADIER.

His rifle is fitted with a "tromblon" for firing rifle-grenades.

fire through the airplane propellers, and had been speeded up to the amazing rate of fire of 1,300 *shots per minute*.

Upon their arrival in Europe the two Browning weapons created a marked sensation both in the armies of the Allies and in our own forces. Not only were they exquisite examples of the gunsmith's art but they could pour lead into the enemy at an unheard-of rate, they were to all intents and purposes foolproof, and they proved themselves capable of standing up under the most trying conditions. The Browning automatic rifle in particular, as beautifully finished and balanced as a trap-shooter's double-barrel, formed a striking contrast to the clumsy French Chauchat, which looked as though it had been made by a village blacksmith. During the summer of 1918 our government was approached by representatives of England, France, and Belgium with inquiries as to the possibility of sufficient Brownings being produced to supply their armies as well as our own.

The 79th was the first division to enter the line equipped with Browning automatic rifles and machine-guns. In view of the various criticisms of these weapons which have appeared from time to time in the American press, it seems worth while to quote from the report of the Ordnance Machine-Gun Officer of that division:

"The guns went into the front line for the first time in the night of September 13th. The sector was quiet and the guns were practically not used at all until the advance, starting September 26th. In the

action which followed, the guns were used on several occasions for overhead fire, one company firing 10,000 rounds per gun into a wood in which there were enemy machine-gun nests, at a range of 2,000 metres. Although the conditions were extremely unfavorable for machine-guns on account of rain and mud, the guns performed well. Machine-gun officers reported that during the engagement the guns came up to the fullest expectations, and even though covered with rust and using muddy ammunition, they functioned whenever called upon to do so."

The design and adoption of the Browning gun not only gave our armies the most efficient and dependable weapon of its kind in the world, but it saved the American taxpayer $75,000,000. This figure is based on the difference in cost to the government of the Browning and its nearest equivalent, the Vickers—the latter at a price representing its cost after having been in war production for three years. The design and adoption of the Browning automatic rifle gave us far and away the best weapon of that type possessed by any army, and it saved the government nearly $13,000,000—not a very large figure, it is true, compared with war expenditures, but nevertheless worth saving.

When the war ended we had on hand 52,000 Browning automatic rifles and 29,000 Chauchats—a total sufficient to arm an army of approximately 3,500,000 men. On the same date there were completed 3,340 Hotchkiss, 9,337 Vickers, and 42,050 Browning guns, thus giving us enough heavy machine-guns to equip over 200 divisions, or an army of approx-

imately 7,000,000 men. Thus it will be seen that, no matter what the future has in store for us, it will be a long time before we will have occasion to worry about a shortage in machine-guns.

Though less novel and, therefore, less interesting than certain other products of Ordnance, there were six items, all produced in stupendous quantities, which rendered greater service than all the big guns, tanks, and airplanes put together in nailing down the coffin-lid on Germany's dream of world domination. I refer to rifles, pistols, revolvers, bayonets, helmets, and small-arms ammunition. They, with the gas-respirator, the water-bottle, the cartridge-belt, and the pack, constituted the equipment of the fighting Yank. They were the infantryman's tools of trade.

When the news of the sinking of the *Lusitania* reached Paris, I heard the then American Ambassador to France assert, in the words of Mr. William Jennings Bryan, whose appointee he was, that were the United States to enter the war, a million men would spring to arms overnight.

'I'll admit, Mr. Ambassador," said a sceptical listener, "that we might get the million men. But where would we get the arms?"

"We'd stamp 'em out, sir," replied the diplomat. "We'd stamp 'em out the way we stamp out tin plates."

But, unfortunately, the matter of supplying weapons for our fighting forces was very far from being as simple as the ambassador seemed to think, for the modern high-power service rifle is a delicately adjusted

and highly finished piece of mechanism, to manufacture which requires the finest quality of materials and the highest grade of expert workmanship. So, though we did not realize the dream of the ambassador by producing arms for a million men overnight, American Ordnance performed a feat almost as amazing by producing *enough rifles to equip an army of seven million men in less than fifteen months.*

Some years before our entry into the war a parsimonious Congress reduced the appropriations for the manufacture of small arms and small-arms ammunition to such an extent that it was found necessary to shut down the rifle-plant at the Rock Island Arsenal and to greatly reduce the output of rifles at the Springfield Armory and of cartridges at the Frankford Arsenal. This resulted, as might have been foreseen, in the dispersion of the large force of highly skilled workmen who had been in government employ, most of them seeking occupation with private concerns or turning to other vocations. When, therefore, our entry into the Great War made it necessary to take up the manufacture of small arms and ammunition on an unprecedented scale, the War Department was dismayed to find that it did not have nearly enough workmen, and that, owing to the enormous wages which were then being paid in other industries, it could not get them. Thus it became necessary, in order to obtain an immediate and adequate supply of weapons for the great new armies which we were raising, to enlist the cooperation of private manufacturers.

The three leading manufacturers of small arms in

this country—the Winchester Repeating Fire Arms Company of New Haven, Conn., the Remington Arms-Union Metallic Cartridge Company of Ilion, N. Y., and the Remington Arms Company of Eddystone, Pa. —were devoting themselves at this time to the manufacture of the British .303 rifle, the production of which, however, due to the decrease in the requirements of the British Government, was gradually slowing down. But, though these plants had every facility for turning out in large quantities the British .303 Enfield, it would have required many months for them to alter their tools and machinery for the manufacture of the .30-calibre Springfield, which was the standard arm of the American service. The Ordnance Department found itself confronted, therefore, by three alternatives. It could change the equipment of these plants so as to permit of the manufacture of Springfield rifles—a proceeding which would have involved a delay of several months; it could adopt the British Enfield, which would also have necessitated the adoption of another calibre of ammunition—an unthinkable thing in time of war; or it could utilize the facilities of these three great plants by modifying the British rifle so that it would take American ammunition. The latter course was decided on.

The modification consisted in changing the magazine, chamber, and bore of the Enfield rifle so that it would take the U. S. service .30-calibre rimless cartridge instead of the British .303 rim cartridge. So rapidly were the plans worked out, the drawings and specifications produced, and sample rifles submitted and tested,

that within less than eight weeks after the declaration of war orders were given to Winchester and the two Remington concerns for a million "modified Enfields," as the new weapons were called. Putting aside the keen trade rivalry which had formerly existed, the three plants virtually operated as one mammoth rifle factory, so that when one shop found itself short of parts it was promptly supplied from another where there was a surplus. The combined factories had so fully gotten into their stride by the fall of 1918 that, when the Armistice was signed, they were turning out approximately 10,000 rifles a day, this being in addition, remember, to the spare parts which were being manufactured at all three plants as well as in the government establishments at Rock Island and Springfield. The records show that more than 2,500,000 rifles had been accepted by November 9, 1918. Add to this the 600,000 Springfields and the 160,000 Krag-Jorgensens which we had on hand at the beginning of the war, the 280,000 rifles which had been manufactured for Russia but which were taken over by the United States, and the 20,000 Ross rifles purchased from Canada, and it will be seen that we had a total of more than 3,500,000 rifles. As only about one-half of the troops in an American division carry rifles, we had, therefore, enough weapons to equip an army of 7,000,000 men.

In spite of the endless complications due to the use by our forces during the early days of the war of French machine-guns and automatic rifles of a calibre different from our own, and to the insistent demands of the Air Service for special types of cartridges—

tracer, armor-piercing, and incendiary—there was never a time when we did not have enough small-arms ammunition to supply our forces in the field. I might mention in this connection that one of the most perplexing problems which had to be solved by Ordnance was the manufacture of ammunition which would function equally well in two rifles—the Springfield and the Enfield—and in seven different types of machine-gun—the Benet-Mercie, the Lewis, the Vickers, the Colt, the Marlin, and the light and heavy Brownings. In these machine-guns the firing-pin points, or strikers, are different in shape and size and function differently, each giving a different weight of blow on the primers of the cartridge, yet, notwithstanding this handicap, the success of the American ammunition in this respect was remarkable. The daily average of small-arms ammunition manufactured in the United States reached the enormous total of 14,900,000 completed rounds—a production equal to that of England and France put together. The total number of cartridges of all classes produced up to the end of the war was 3,500,000,000; enough, if placed tip to primer, to put a girdle of brass and steel around the globe.

At the outbreak of the war the Colt automatic pistol, of .45 calibre, was the standard arm of the American Army. This pistol was manufactured by Colt's at Hartford, Conn., and by the government at the Springfield Armory. The Ordnance Department quickly realized, however, that even the combined capacity of these two plants would prove wholly inadequate to meet the demands of the new armies,

whereupon it obtained permission from the War Department to supplement the supply of automatics with arms of other types, particularly Colt and Smith & Wesson .45-calibre revolvers—the famous "six shooters" of the plains. These revolvers did not take the rimless, or cannelured-head, cartridge used in the pistols, but this difficulty was overcome by means of a loading-clip, which had the additional advantage of enabling them to be loaded almost as quickly as an automatic. The revolver, which is somewhat less accurate and less powerful than the pistol, and which is considerably more tiring for the user, was adopted as an emergency measure only, due to the imperative necessity of supplying the troops. The demands of the A. E. F. increased so rapidly, however, that in the summer of 1918 contracts were let to eight other firms possessing equipment which could be converted to the manufacture of pistols and revolvers. It is interesting to note that among the concerns which turned from the manufacture of essentially peace-time devices to the production of implements for killing the Hun were the Burroughs Adding Machine Company and the National Cash Register Company. At the signing of the Armistice, there had been produced a grand total of 375,000 pistols and 268,000 revolvers, and the rate of production was rapidly increasing, thereby bringing us within sight of the day when, in accordance with the plans of the General Staff, it would be possible to arm every American soldier with that characteristically American weapon, the "shooting-

Another innovation introduced by the Great War was the steel helmet, which, barring a few European heavy cavalry regiments, had not been used by any civilized army since Cromwell's time. The British helmet was originally adopted by our forces as a temporary expedient, in order to gain time until experiments would show whether it was possible to produce a better one. After a lengthy series of tests, however, it was decided to retain the British model, manufactured from steel with a considerable manganese alloy, rolled by an American process. Any possibility of the position of our troops being betrayed by the reflection of light from the surfaces of their "tin hats," as was occasionally the case with the Germans' steel headgear, was eliminated by dipping the helmet in olive-drab paint, scattering sawdust over the surface with a blast of air, and then repainting after the first coat had hardened, thus producing an extremely coarse sanded appearance. The netting used in the lining of the American helmet was, however, a distinct improvement on the British design, as it lessened the inconvenience caused by the very considerable weight—slightly over two pounds—and the small pieces of rubber around the edge of the lining served to keep the metal away from the head, so that even relatively large dents caused by bullets or shell splinters did not reach the wearer's skull. The task of designing our helmets and body armor was intrusted, fittingly enough, to Major Bashford Dean, who was admirably fitted for the duty by reason of the fact that he has been for many years curator of the armor collection in the Met-

ropolitan Museum of Art. It is a curious fact, and indicative of the extent to which Army Ordnance converted to war purposes countless peace industries, that the steel for our helmets was furnished by the American Tin Plate Company—no wonder that the soldiers called them "tin hats"!—the linings were produced by various shoe manufacturers, and the helmets were assembled and painted by the Ford Motor Car Company!

I tried to make it clear at the very outset of this chapter that the story of Ordnance is so stupendous that the best I could hope to do in such a narrative as this would be to dwell briefly on its most salient points. This necessitates my passing by with a few words discoveries and developments of the greatest interest and importance, and of dismissing amazing achievements with a paragraph. Take the Nitrate Division of the Ordnance Department, for example. Were it to receive its due, an entire chapter should be devoted merely to outlining its problems, while a whole book could be written on how it solved them.

Nitric acid is the basis of all modern explosives. A country possessing no nitric acid would be virtually unable to fire a single shot. Before our entry into the war we depended for our supply of this essential ingredient upon the sodium-nitrate beds of Chile—the only country in the world where nitrates have been found. Germany had done the same, having had the foresight, moreover, to accumulate a reserve supply estimated at 375,000 tons. Had she not taken steps, however, to replenish this enormous stock by produc-

ing nitrates from the air by the so-called "fixation method," she would inevitably have been compelled to capitulate when her supply became exhausted. It quickly became apparent that if we continued to rely upon Chile for our supply of nitrates we would be courting disaster, for Chile, though neutral, had decided German leanings, and there was always the danger, therefore, that German diplomacy or threats might cause her to place an embargo on nitrate exports. Even had this danger not existed, our available tonnage was extremely limited and a few torpedoings of nitrate ships would have stopped our supply, thereby automatically paralyzing our manufacture of explosives. It was determined, therefore, to make the United States wholly independent of any outside source by the erection of four enormous plants for the manufacture of nitrates by the synthetic ammonia and cyanamide processes.

Two of these projects—U. S. Nitrate Plant No. 1, at Sheffield, Alabama, and U. S. Nitrate Plant No. 2, on the Tennessee River at Muscle Shoals, Alabama—were both completed before the signing of the Armistice. Plant No. 1, which has a capacity of about 22,000 tons of ammonium nitrate a year, cost approximately $13,000,000. Plant No. 2 makes five times that amount of ammonium nitrate and cost five times that sum. Plant No. 3, at East Toledo, Ohio, and Plant No. 4, at Ancor, near Cincinnati, were about one-quarter completed when the Armistice was signed, but, because of the changed conditions governing the supply of Chilean nitrates as well as the facilities which

we now possess in Alabama for manufacturing them ourselves, they have been discontinued. In addition to these enormous projects, a chemical plant was erected at Saltville, Virginia, at a cost of $2,750,000, for the manufacture of sodium cyanide to be used in the production of poison-gas. Though no operations are now (May, 1919) being carried on at any of these plants, it is believed that their products will be in wide demand for farm fertilizers, a project being under consideration whereby nitrates can be produced at these plants and sold to farmers at about three-quarters of the price paid for the Chilean product.

This chapter already so bristles with statistics that a few more can do no harm. They may open your eyes, moreover, to the magnitude of our preparations for producing nitrates—a project which has cost the American people more than $120,000,000, but of which not 1 in 10,000 of them has so much as heard. Take Plant No. 2, at Muscle Shoals, for example. I would be willing to wager almost anything you please that you have never heard of Muscle Shoals before. For your information it is on the Tennessee River, in northern Alabama, about midway between Nashville and Chattanooga. The power-house of this plant, with its capacity of 135,000 horse-power, has the largest annual output of any steam-power plant in the world, developing two-thirds as much power as all the hydroelectric plants at Niagara Falls put together. It contains a 90,000 horse-power steam-turbine—the largest ever built. The ammonia-gas plant is the largest in the world. The liquid-air plant is five times larger

than any other installation of its kind in existence. At its peak the camp at Muscle Shoals had a total population of 21,000. One of its score or more of mess-halls seats 4,000 persons at one time; in it 750 gallons of soup have been prepared and 2 tons of meat have been roasted for a single meal. More than a thousand hogs were raised on the waste from this mess-hall alone. (Attention of Mr. Hoover!) The camp laundry washed 6,000 blankets in a single day. That may give you some idea of the labor and money involved in preparing to make our own nitrates.

When it is considered that the personnel of the Ordnance Department, at home and overseas, consisted of 6,000 officers and nearly 100,000 enlisted men—almost as many as we had in the entire Regular Army before the war—and that these officers and men were called upon to perform work of a highly technical and specialized nature, it will be seen how important was the work of the Training Division. Among the innumerable activities of this division was the Ordnance Engineering School, where in three months a technically trained engineer was given an insight into the design and manufacture of ordnance materials; the Powder School at Carney's Point; the Ordnance Supply School at Fort Hancock, and the Machine-Gun School at Springfield. In addition to these there was a school for tractor operators, a school for instruction in the repair and maintenance of ordnance trucks, another for the repair and maintenance of railway-artillery, and still another for training men in the repair

of optical and precision instruments. It is sufficient for an infantryman to know how to use a pistol, a rifle, and a machine-gun, but the men who wear on their collars the insignia of the Ordnance Department have to know not only how to operate those weapons, and how to give instruction in their operation to others, but they have to be familiar with every detail of their manufacture and repair.

By far the most fascinating feature of Ordnance activities in America is the great proving-ground at Aberdeen, Maryland, thirty miles from Baltimore, on the shores of Chesapeake Bay. On this remote and jealously guarded reservation is tested every weapon and device, with the exception of small arms, produced by the Ordnance Department. During the height of our war preparations, more shots were fired here in a single day than were fired at the old proving-grounds at Sandy Hook in a year. A far greater quantity of explosive was expended daily than was used in many of the important battles of the Civil War. Here can be seen in action every type of American artillery from the vicious, hard-hitting little 37-mm. infantry cannon to the camouflaged monsters on railway-mounts, streaked like zebras and spotted like giraffes, which can drop a ton of explosive on a given target thirty miles away. Giant tanks, looking for all the world like some strange species of prehistoric monster, smash their way through patches of woodland or take twelve-foot trenches in their stride; field-guns of all calibres, camouflaged and tractor-mounted, go rocking and reeling across the broken fields; airplanes, circling in the blue, drop their half-ton bombs upon

the targets marked out on the fields below; showers of shrapnel from the antiaircraft guns burst about the target parachutes in suddenly unfolding blossoms of white and scarlet. In the recovery-fields hundreds of men are at work with pick and shovel retrieving the fragments from the shell-bursts in order that they may be studied by the experts in the laboratories. (In order to facilitate this extremely important work, there has recently been built a huge concrete reservoir, known as a "recovery-tank," into which the shell are fired, the fragments being recovered by means of giant magnets.) In the powder-bag department one can see storerooms filled to the ceiling with rolls of the heavy silk used for making the bags in which the propelling charges are contained; in adjoining rooms—"sweat-shops" they are jokingly called—scores of enlisted men, trained in the clothing-shops of New York's East Side, cut and stitch the silk into cylindrical sacks in sizes to fit the various calibres of guns, and some distance away, in small, isolated buildings, other men fill the sacks with greenish-yellow granules which look like mildewed macaroni, but which is really smokeless powder. Over *ten thousand miles* of this silk was required for our war programme. And it had to be the finest quality of silk, for no other material could be depended upon not to leave smouldering fragments in the barrel after its discharge, which would mean a burst gun and death to the crew when the next charge was inserted. Everything considered, one can get more thrills and see more things of interest at Aberdeen than at any place I know.

When time has given it the justice of perspective,

the war-effort of Army Ordnance will be recognized as the greatest industrial achievement in the history of mankind. The more one learns of it the more it staggers the imagination. In nineteen months the Ordnance Department effected the most complete mobilization of science and industry the world has ever seen; it produced munitions of certain classes in unprecedented quantities; it developed and supplied material of such superior design and workmanship as to win the praise of our allies and the grudging admiration of our enemies; it designed, manufactured, and sent overseas the best service rifle, the best automatic rifle, the best pistol, the best machine-gun, the best field-gun, the best railway-artillery, the best tractor, and the best motor-truck possessed by any army in the world, and it stood ready, when the Armistice was signed, to turn loose on Europe such an avalanche of munitions as the world had never dreamed of. The American people seem to have completely overlooked the fact that we had in full swing, after we had been at war less than forty weeks, a mightier munitions programme than Germany could attempt after preparations which took forty years. But, though the American people did not realize the stupendous magnitude of their own effort, the Germans did. It was the news of the programme adopted by Army Ordnance, and the realization *that it was going through*, which, more than any single factor, perhaps, convinced Germany of the utter futility of further resistance. The Ordnance Department, like the biblical prophet, was not without honor save in its own country.

VI

FIGHTERS OF THE SKY

AT about the time that the German War Lord, resplendent in the eagle-crowned helmet and silver cuirass of the Guard Cuirassiers, was haranguing in sonorous phrases the punitive expedition which was about to depart for China, two young mechanics in greasy overalls were at work in an obscure machine-shop in an Ohio city on a strange invention which was destined to prove a far more potent weapon than the Kaiser's boasted "shining sword." Now it is certain that at this period the All Highest had never heard of these young mechanics, and though they, of course, had heard of him, I imagine that to the accounts of his spectacular doings which appeared almost daily in the newspapers they paid about as much attention as they did to the gaudy lithographs on the local bill-boards which heralded the annual visit of the circus. Yet, could William of Hohenzollern have looked a dozen years into the future, he would have seen that these two silent, earnest, unassuming brothers from the Middle Western town were destined to have a profounder effect on the future of the great empire which he ruled, and, indeed, on the history of the world, than he and all the princes, soldiers, and statesmen who surrounded him.

Notwithstanding the jibes and forebodings of the professional critics, the ponderous sarcasms of senators and congressmen, and the sensational stories of failure

which have appeared in the press, there are few more brilliant chapters in our national history than the story of the airplane. Do you realize, I wonder, that the airplane is the development of barely a decade? Had a life-insurance company, ten years ago, learned that one of its policy-holders was planning to take a ride in a "flying-machine," it would promptly have cancelled his policy. Yet to-day planes carrying the air-post between the cities of the Eastern seaboard go booming down the air-lanes as regularly as express-trains and without attracting much more attention.

The story of the airplane, so far as its relation to the American Army is concerned, begins on the little flying-field of Fort Myer, on the Virginia side of the Potomac, opposite Washington. In the late winter of 1907 the Signal Corps had issued an advertisement and specifications for a heavier-than-air flying-machine, the chief requirement being that it must remain in the air for an hour without landing. Most of us will remember the world-wide interest which was aroused by this promised realization of the dream of the ages. During the trials the eyes of the world were centred on the parade-ground at Fort Myer. The President and the members of his cabinet were in frequent attendance and even Congress adjourned when it was announced that a flight would take place. The story of how the strange contrivance, looking like a combination of a box-kite, a baby-carriage, and a windmill, which had been brought on from Dayton by the two sober-faced brothers, was trundled out onto the field; how, after skimming along the ground, it rose into the air as

gracefully as a swallow, and how, after fulfilling every condition imposed by the War Department, the first machine was purchased by the government, needs no elaboration here. The most amazing feature of the affair, barring only the performance of the airplane itself, was the fact that during the eight years following the demonstration at Fort Myer *the entire appropriations by the government for military aeronautics amounted to less than a million dollars.* Think of it, my friends! With the secret of aerial navigation in our hands—a secret which had been sought for by scientists all down the ages—Congress devoted less money to its development during the first eight years than it spent on many a post-office or government building. But the astounding apathy which characterized our attitude toward this epoch-making invention did not extend to the great European nations. They, always seeking to obtain military superiority, instantly recognized the significance and the potentialities of those early flights at Fort Myer. France, in particular, during the next few years making marked advances in aircraft design and construction. Thus it came about that when the war-cloud burst over Europe in the summer of 1914 the United States, where the airplane had its birth and where it had first demonstrated its practicability, possessed only a few decrepit and almost obsolete training-machines, while our fliers could almost have been numbered on the fingers of one's two hands. Whose was the fault for this deplorable and inexcusable condition? A certain amount of blame undeniably attaches to the army, for in those days many of our higher officers

were graduates of the old Indian-fighting school, who regarded with doubt and scepticism the claim that these new-fangled flying-machines could have any real military value. I think, however, that the real cause of the neglect in developing the airplane could have been found in the building with the great white dome which stands at the far end of Pennsylvania Avenue.

As a direct consequence of our systematic discouragement of airplane development, when we entered the war there was no such thing as an aviation industry in the United States and the number of aeronautical engineers and designers was so small as to be practically negligible. In this respect the problem of developing an air-fleet was unique. The United States had built ships before, it had manufactured cannon, rifles, ammunition, it had fed and clothed and housed armies, and it had at its command thousands of men qualified to do these things and do them well, but, barring a handful of experts in Dayton and Buffalo, there was no one in this country with experience in the designing or building of either training or fighting planes. In short, the government was faced with the problem not merely of developing a new industry, but of *creating* it.

In April, 1917, there were being built in the United States only four makes of aircraft engines that were sufficiently developed to be of any military value, and even these were useful only for primary training. We had no engines suited for service on the battle-front, or, indeed, even for the advanced training of pilots.

Though the largest engine manufactured in the United States at this time developed about 220 horse-power, it had not measured up to the exacting requirements of combat. The other American-built engines ranged from 90 to 135 horse-power. It being evident, therefore, that the existing American engines could be used only for purposes of preliminary instruction, it was accordingly decided that their further manufacture should be limited to the training requirements. As a result of this decision, by far the greater part of the primary training of pilots has been conducted with the Curtis 90 horse-power engine, a quantity production of which was obtained early in the war, this engine being particularly valuable owing to the very satisfactory training-plane which had been designed around it. Considerable use was also made of the Hall-Scott 100 horse-power engine until the Curtiss motor could be manufactured in sufficient numbers to meet all demands for primary training. Two European engines, the Gnome 100 horse-power and the Hispano-Suiza 150 horse-power, were also being put into production in the United States at this time. These engines represented the highest product of European design and engineering skill, and were in a perfected and standardized state, at least according to European ideas, when their manufacture was undertaken in this country. But the changes involved in adapting them to manufacture by American methods required so much time, and the advances made in aeronautical engineering were so rapid, that before they could be produced in sufficient numbers they were almost obsolete for service on the

front. These two engines were, however, of unquestioned value for advanced training purposes, the Hispano-Suiza in particular playing an important part in this work. Later another European engine, the 80 horse-power Rhone, was also put into production.

One of the serious mistakes into which the Allies had fallen at the time the United States entered the war was the development of such a multiplicity of types of engines and planes that it was impossible to have a large number of any one of them. Indeed, by the spring of 1917, there were almost as many types of planes skimming over the Western Front as there were types of motor-cars skimming over American roads. As a direct consequence of this condition, the trained personnel had grown to such proportions that it was estimated that from thirty to fifty men were required on the ground to keep each plane in the air. It was obvious, therefore, that unless this large number of trained attendants could be materially reduced, it would be hopeless to expect to put thousands of fighting planes into the air within a reasonable time, for, on this basis, 1,000 planes would require from 30,000 to 50,000 men to take care of them. It was realized, moreover, that copies of foreign designs could not be made available in time to answer the insistent demand that America should put on the front an air force of overwhelming proportions.

Although, immediately upon the declaration of war, an aircraft commission had been sent to Europe for the purpose of gathering first-hand information,

public sentiment would not have permitted the government to sit idly by and wait with folded hands for this commission to make its report. What the country demanded was action with a capital A. Now it is not generally known, perhaps, that, instead of engines being designed for certain types of aircraft, the most successful airplanes are designed around specific engines. And, as the development of the engine requires the greatest expenditure of effort and time, some one suggested that, instead of waiting for the members of the commission to come home and tell about the European engines they had seen, to manufacture which under American conditions might well prove impracticable, an all-American engine, combining the best features of the various European types but particularly adapted for manufacture under domestic conditions, be designed by the best engineering talent in the country and immediately placed in production. At a meeting of representatives of the Signal Corps—which then had charge of military aeronautics—and the Aircraft Production Board it was decided to put this suggestion into immediate execution, at the same time purchasing in Europe whatever equipment might be available in order to tide over the period while the all-American engine was being put into production.

At noon on May 29, Lieutenant-Colonel J. G. Vincent and Lieutenant-Colonel E. J. Hall, two of the most brilliant automotive engineers in America, shut themselves in a room of the New Willard Hotel in Washington. When they left that room again on the afternoon of the 31st, though haggard from lack of

sleep, they had in their hands the completed assembly drawings of an entirely new airplane engine. Thus was born the famous Liberty engine, about which hundreds of speeches have been made and thousands of columns have been written in scepticism, in criticism, and in praise. As the result of the enthusiastic co-operation of some ten manufacturers, each of whom produced those parts for which his factory was best fitted, the first Liberty, an 8-cylinder, was built in thirty days. The first 12-cylinder engine completed its official endurance test eighty-two days from the time the order for samples was given, the unqualified success of this test removing the Liberty from the realm of experimentation to that of established reputation. In just one year from the day that Lieutenant-Colonels Hall and Vincent pushed the thumb-tacks into their drawing-boards in the hotel room, 1,100 Liberty "twelves" were produced—a remarkable illustration of the ability and ingenuity of American engineers and the energy and resourcefulness of American manufacturers. Thanks to the energetic co-operation of many manufacturers, more than 14,000 Liberty engines had been completed when the Armistice was signed. There are few finer passages in the history of America's participation in the war than the story of how our manufacturers put aside their private interests and their commercial rivalries and threw themselves and their organizations, heart and soul, into the work of building an airplane that would make America mistress of the skies.

When the signing of the Armistice brought our

efforts to an abrupt conclusion, there had been developed, tested, and adopted by the army four types of airplanes, production of which would have started early in 1919. They were the Lepere, or L. U. S. A. C. II, a two-seated fighting-plane equipped with a Liberty engine; the U. S. De Haviland 9-A, a day-bombing and reconnaissance plane also fitted with the Liberty engine; the huge Martin bomber, with a gross weight of nearly 5 tons, driven by two Liberty engines; and the Loening, a two-seated combat plane fitted with the 300 horse-power Hispano-Suiza engine.

A striking illustration of the new problems and extraordinary ramifications incident to this great new industry which so suddenly came into existence in the United States is the fact that it was found necessary to despatch an agricultural expert post-haste to India to purchase enormous quantities of castor-beans, as it was at first believed that castor-oil was the only satisfactory lubricant for these new types of high-speed, high-power engines. India's stock of castor-beans being quickly exhausted by the immensity of our demands, more than 100,000 acres of the bean were planted in the United States. Meanwhile, research work with mineral oils was carried on intensively, a lubricant eventually being developed which proved satisfactory in practically every airplane engine except the rotary type, for which castor-oil is still preferred.

But the aircraft problem was by no means solved with the development and production of the Liberty engine. Far from it. To build airplanes requires wood; the best timber in the world is none too good;

and of suitable timber there was a comparatively limited supply. The best wood known for airplane construction is the Sitka spruce, which combines the required qualities of strength, resiliency, and lightness. This spruce grows mostly in the Pacific Northwest, along the tide-lands of Washington and Oregon, at a low elevation. But not all the planes were built of spruce, fir, as it grows in the Northwest, being largely used for the heavier wing-beams. Port Orford cedar was eagerly utilized whenever it could be obtained. It is of somewhat smaller growth than spruce or fir, but a straighter-grained wood, harder and more dense than either of the others. Of this splendid wood there is, however, only a comparatively small quantity, 2,000,000,000 feet, perhaps, anywhere in the world, mostly near Coos Bay, on the coast of Oregon. Being less affected by water than any of the other woods, it was reserved for use in seaplanes. The government commandeered the entire supply of Port Orford cedar for aircraft production, but released it upon the signing of the armistice.

There is plenty of suitable airplane timber—spruce, cedar, and fir—in the Far Nor'west—miles and miles and miles of it. The mountain-slopes are as solid a black with the evergreens as though a giant had painted them with soot. "Massed in their black battalions stand the bleak, barbarian pines." Foolish men have tried to destroy these forests. Twenty years ago a colony of Poles settled amid the virgin forests of the Olympic Peninsula—a portion of the United States which to this day remains virtually unexplored.

Timber was not worth a dollar a million feet then. On the chance that the ground might be tilled if the timber could be cleared off, the settlers started a fire that burned over ten square miles and destroyed timber which, at prevailing prices, would be worth close to half a million dollars. The great area of blackened waste which remains is still known as "The Polander Burn."

Now spruce, curiously enough, had not been considered a valuable wood for the ordinary lumber trade; the lumbermen held it a doubtful asset that was hardly worth the cutting. As a result of this condition, the commercial supply was neither large enough nor well enough selected and prepared to meet our aircraft requirements when the declaration of war suddenly made it one of the most desired and most valuable woods in existence. Thus it came about that, the lumbermen being unable to supply the demand, the army had to go instantly into the business of producing this wood in theretofore undreamed-of quantities. The work of getting out the spruce fell, rather oddly, to the men who had been among the first to volunteer for extrahazardous service in France. Before the war, when airplanes were looked on merely as toys of the rich, the supervision of military aeronautics was assigned to the Signal Corps, on the assumption that if flying had any part in warfare it would probably be that of signalling, for which reason, and the more potent one that no other branch of the service knew what to do with it, it had to be wished on some one. And of all the branches of the army, possibly none save the

Flying Section of the Signal Corps—as the Air Service was then known—had a more adventurous and devil-may-care personnel. The Signal Corps made its original appeal to the men who wanted to get out and do things: to be in front, to wave the little red-and-white flags under shell-fire, to sound the long yell, to see the enemy first, to be the eyes and ears and nerves of the whole army. But, as I have already explained, the army had to have the spruce in order to carry out its aviation programme, and aviation was under the Signal Corps, and it was from the Signal Corps, therefore, that the men were drawn to go out to the Northwest and get the spruce. Thus it came about that the boys who enlisted at the very beginning in order that they might have the danger and excitement of laying the field telegraphs and telephones, of dashing madly along shell-swept roads on roaring motorcycles, of wigwagging and semaphoring word of the enemy's movements from in front of the armies, were shipped westward instead of eastward, were given axes instead of Enfields and peaveys instead of pistols, and fought their share of the war in the gloomy depths of the primeval forest, or on the logging railroads and in the sawmills which they built in bitter cold and driving rain.

Labor conditions were undeniably bad in the Northwest at the beginning of the war. There is an old proverb that "A farm lease is a conspiracy on the part of the tenant and the absentee landlord to rob the land." Lumbering was almost as bad. The owners were avaricious and arrogant, the men stubborn and defiant. The

owners would not make camp improvements because "the men would not stay on the job," and the men would not stay because "the owners didn't make things decent." And, to make things worse, the paid German propaganda was rampant, unchecked in the woods, for the Wilhelmstrasse fully realized how vital it was to cripple the American air programme. Germany knew better than we did the war possibilities of the Pacific Northwest. She couldn't buy spruce there for her planes, but she could mobilize her spies and trouble-makers and hinder the production for and the delivery of spruce to the United States and her allies. And she did her worst. Some day there will be told the story, the "inside" story, of the campaign waged in the Great Woods by the secret forces of Germany—a campaign consisting of strikes, I. W. W. demonstrations, forest-fires, railway wrecks, dynamited bridges, damaged machinery, infernal machines, shootings, systematic intimidation, and all the other deviltries of a vicious and unscrupulous enemy. The spies and secret agents which Germany planted in the forests of the Northwest formed a part of the vast army of which the Kaiser boasted to Ambassador Gerard. But the Hun made a miscalculation. There were not enough spies; there were too many Americans.

The War Department has rarely shown greater wisdom than when it gave a colonel's commission to Brice P. Disque, an ex-captain of Regulars who had left the army to accept the wardenship of the Michigan State Prison, and put him in charge of spruce production. Captain Disque had his blanket-roll packed and

aboard ship for service in France when he was called to Washington, just as the transport was setting sail, and ordered to go to the Northwest and investigate lumbering conditions. His report showed that the right man had been found to direct the Titanic job of getting out the spruce; he was commissioned a colonel and later a brigadier-general, and the story of the spruce production tells the rest.

To the tact and vision of General Disque is due the creation of that remarkable organization known as the Loyal Legion of Loggers and Lumbermen, an association conceived to bring capital and labor together in one mighty machine driven solely by patriotism. Under the inspiration thus provided, both sides agreed to submit their differences to the United States Army, as represented in the person of General Disque, as final arbiter. The eight-hour day was agreed to; camp sanitation and better living conditions of every kind were demanded; a uniformly liberal wage-scale for all classes of labor was adopted; a standard mess was arranged to check the inordinate waste of food in the lumber-camps; the owners were given profitable prices for their output under the new conditions, and the small men were assured of receiving a square deal from their powerful corporate rivals. Some of these questions were settled through regular military channels, but most of them through the medium of the L. L. L. L. Once a matter could be shown to be reasonable and fair to every one concerned, it was officially adopted, as by a majority vote, and business as well as patriotic reasons demanded that every one should cheerfully ac-

quiesce in the decision. The Loyal Legion works—for it has been made permanent—through its local assemblies; any local disagreement is taken to the district council—which is formed from local representatives of both employer and employees, there being eight of these district councils in the Coast Division and four in the Inland Empire. Any question which cannot be settled by a district council goes to the Central Council, composed of one employer and one employee from each district; while General Disque, as the head of the Legion, has been the final arbitrator in such questions as the Central Council could not settle. Since this plan was definitely adopted, however, so strong a spirit of patriotic fairness has been developed on both sides that nothing has gone to him for settlement or revision. Nothing could more strongly emphasize the success of the Legion, which now has a membership of nearly 130,000, than the fact that at a mass convention, held shortly after the signing of the Armistice, at which more than 900 local councils were represented, it was voted almost unanimously to perpetuate the organization, to continue the publication of its official bulletin, and to invite General Disque to continue as the Legion's head. Were the people of the Pacific Northwest to receive no other reward for their sacrifices in the war, they have reason to feel amply repaid by the creation of the Loyal Legion and the resultant ending of the long-standing feud between capital and labor, the expulsion of the I. W. W.'s and similar discordant and dangerous elements, the betterment of working and living conditions for the lumbermen, and the com-

mencement of an era of peace and prosperity in the Great Woods.

Unless you have been in the Northwest during the rainy season you can have no adequate conception of the difficulties under which the spruce squadrons labored. The coastal districts of Oregon and Washington have one of the heaviest rainfalls recorded anywhere on earth. Unkind people have said of the Pacific Northwest that it has but two seasons—the rainy season and August. But that is an exaggeration. The local newspapers alternately boast of and apologize for the reputed 180 inches, or 15 feet, of annual precipitation. With that as a basis for one's calculations, the old man who sold the town site of Simescarey, the terminus of the spruce road which the government has built into the Olympic Peninsula, has had 450 feet of water descend upon his head—for the inhabitants of that region scorn umbrellas—in the thirty years that he has resided there. After a winter spent in the Northwest—and having passed one there, I know whereof I speak—one might easily believe that the sentry at an Oregon spruce-camp was not joking when he came in to the commanding officer to report the damages done by the rain.

"Sir," he apologized, "I don't like to be a pessimist, but things ain't going right to-day. Most of the fish in the lake are dead since last night's rain. The lake raised so fast that some of 'em got beyond their depth and was just naturally drowned; the rest couldn't swim up fast enough, and bein' surface fish and not

used to much depth, their bladders busted and there ain't a fit fish left in the whole bunch. Every duck but one is dead, too; the rain beat their heads into a mush—all but the one that got caught in a steel trap set for a muskrat and that saved his life—he stayed under water where it was dry. Believe me, sir, that was the wettest rain last night I ever see."

Because, as I have already explained, the lumbermen did not consider spruce a profitable wood to handle, few of the spruce forests had been penetrated by railroads. So Disque and his Legionaries set out to build railways themselves—13 lines with more than 300 miles of trackage. The forests tapped by these new lines and their branches have, it is estimated, an ultimate production of 33,000,000,000 feet of lumber, a quantity almost beyond the comprehension of the human brain. In order to visualize it, it must be translated into commonplace, every-day terms. Let us assume that it requires 20,000 feet of lumber to build an average 5 or 6 room house. Taking this as a basis, the railways built by Disque and his spruce squadrons have brought within the reach of commerce enough timber to build almost 2,000,000 of these comfortable American homes, with sufficient waste wood to keep them heated for a generation. When the war ended, 174,000,000 feet of aircraft lumber had been cut and shipped—enough to build dwellings for the inhabitants of a good-sized city.

The government planned to have all the airplane stock from the Northwest cut at the one great cut-up

plant at Vancouver, near Portland. This huge mill, the largest in the world, was built by the army in forty-five days and has handled more than a million and a half feet of lumber in twenty-four hours. But with the extension of the airplane programme, whereby the Spruce Division was called upon to furnish stock for all the Allies, more capacity was required and three other great plants of almost equal size were planned, one being ready for opening, one almost completed, and one projected when the Armistice was signed. These four huge mills would, it is estimated, have furnished the United States and her allies with close to 100,000,000 feet of airplane lumber a month.

The silent, peaceful forests of the Northwest seemed separated from the war by a million miles, a score of generations. But when the word was flashed from Washington to Disque to "Go ahead," the primeval silence of the woods was suddenly shattered by a million bellowing echoes of battle. The war had come to America. Almost overnight the battle-front moved 6,000 miles westward—from the forests of the Argonne to the forests of Oregon. The trucks were brought in—endless caravans of grunting, straining monsters; the soldiers came, 30,000 in all; the loggers, graders, hard-rock men, sawyers, surveyors, engineers; the pile-drivers, the donkey-engines, the steam-shovels perched on wheels, the train-loads of food and tools and powder; the patient, sweating horses and the creaking wagons, thousands upon thousands of them. The wood roads were black with traffic; they fairly smoked with the fierce fight for speed. The

highways were dust in the early fall, where the 5 or 15 ton loads ground the roads to powder. Then the wet weather came—fogs, mists, drizzles, showers, floods—the rainy season that grows the incomparable forests of the Northwest.

They splashed through it all, soldiers and Legionaries alike; they waded, they swam, they shivered and swore, and beat their hands over the brush fires—but the stream of supplies never stopped nor checked. The railway gangs, following close on the heels of the axemen, laid their twin lines of steel through the dripping forest faster than Kitchener laid down his desert railway to Khartoum, the locomotives crawling one mile, two miles, deeper into the wilderness each night. Night and day the forest trails were busy. Shuttling back and forth, loaded both ways with materials and men, teams and trucks and trains struggled for speed. Headlights, lanterns, shouted warnings, guided the night traffic along the sombre, shut-in ways. Clankings, clatterings, gasoline coughings, the honk of horns and the hoot of locomotives filled the air. The silent forest became a bedlam of sound, of action.

The spruce! The fir! The wings of victory! Berlin heard it, saw it first. The splitting blasts that showered the forest lakes with stones, the shouting, heaving din of the construction-camps, the crash of the trees as they fell before the axe and saw of the woodsmen, the whine of the cables through the sheaves as the huge logs were snaked into position for loading, the rumble and roar of the heavy-laden log-trains, the shriek of the giant saws in the mills—all these sounds

fell upon the listening ears at German Great Headquarters with a growing menace, as ominous as the tattoo of the machine-guns, as the thunderous blast of the great Allied cannon, as the victorious cheers of the charging Yanks. They meant that the spruce was coming! The planes were coming! A few months more and the boasted Hindenburg Line would be a joke. The Germans knew that they could not build trenches in the clouds. That was the real reason why they were attacked by yellow fever in the fall of 1918.

The engines and the planes themselves being in production, the next problem to be solved by the War Department was to provide our new aerial navy with armament in the form of machine-guns. Fighting in the air, it should be remembered, is entirely a development of the Great War, the adaptation of machine-guns for airplane use having practically all taken place since 1914. Though the records show that a machine-gun was successfully fired from an airplane in this country in 1912, and though the French had a few heavy planes fitted with mitrailleuses at the outbreak of the war, it was not until 1915 that machine-guns were carried by planes on active service. Prior to that time aviators depended on service and automatic rifles, pistols, shotguns shooting large shot held together by wires—miniature editions of the chain-shot used by early sea-fighters—and also carried darts and grenades to drop on the enemy. As a matter of fact, in one of the first aerial combats of the war, which took place on the Eastern Front between a Russian aviator and an

Austrian, weapons were not used at all. The Russian determined to wreck his adversary and, in pursuance of this plan, so manœuvred his plane that the tips of his wings were just beneath the wings of the Austrian. He then suddenly elevated that end of his plane, hoping to upset the Austrian, but the result was that both machines collided and fell to the ground. Major Eric T. Bradley, formerly in the British Army but now an officer of the American Air Service, tells of having flown over the lines in 1915 armed with a twelve-gauge double-barrel shotgun loaded with buckshot tied together with wire, which swished through the air like the lash of a whip and occasionally hit something—usually by chance.

The development of methods for controlling machine-guns so that they can be fired through the area traversed by the propeller has had a vast effect on aerial combat, and an understanding of the problems involved is necessary in order to appreciate the difficulties which had to be overcome. The various devices which have been developed for controlling the fire of a machine-gun so as to cause the bullets to miss the blades of the propeller are commonly known as synchronizing or interrupter gears. These terms are, however, somewhat inaccurate, as it is only occasionally that the speed of the propeller is equal to the rate of fire of the gun, which is the condition of synchronization; moreover, the gun is not interrupted, but is caused to fire at the proper moment so that the bullet will miss the propeller-blade. "Gun control" would be a more descriptive name for the device.

Tractor airplanes—those which have the engine and propeller in front—were early found to be better suited to combat work than planes of the "pusher" type, which have the propeller behind, because they possess greater manœuvring powers and are better able to defend themselves. With these planes was developed the fixed aircraft machine-gun. This gun is fixed rigidly to the plane, pointing straight ahead, parallel to the line of flight. The first fixed guns were mounted on the upper plane so as to shoot over the arc described by the propeller, but these were not satisfactory owing to the difficulty in reloading the gun. To overcome this very obvious disadvantage the gun was lowered, which brought its line of fire inside the arc described by the propeller blades. Thus arose the difficulty caused by shooting into the propeller, to solve which countless experiments were made and numerous expedients tried. At first the blades were armored at the points where the bullets would strike, with steel of a shape calculated to cause the bullets to glance off, but this system was never satisfactory. Then the experiment was tried of wrapping the propeller with linen to keep it from splintering, as it was found that several bullets could be fired through a propeller thus treated without causing it to break. Throughout the summer of 1915 all of the Nieuport fighting-planes used by the French were fitted with fixed guns shooting through the propeller—if a bullet hit the propeller it either went through it or it wrecked it.

There is considerable disagreement as to who invented the device for controlling the fire of a machine-

gun so as not to strike the blade of the propeller, but it is admitted that the Germans were the first to make any extensive use of it, introducing it on the Fokker monoplanes, which caused so much damage on the Western Front in 1915. Shortly thereafter the Allies adopted similar devices. When the United States entered the war neither the Ordnance Department nor the Aviation Section of the Signal Corps had had any experience worthy of the name with aircraft guns. And if they were ill-informed on the subject of guns, they were appallingly ignorant on the subject of gun controls. A few months of study and experiments served to materially increase the War Department's knowledge along these lines, however, and by the time the planes were ready to receive the guns we had adopted a device known as the Constantinisco control. I should explain, perhaps, that there are two distinct types of gun control, both of which were in use when hostilities ceased. One is hydraulic, the other mechanical. The operation of both types is somewhat similar. In each case a cam mounted on the shaft of the engine actuates a plunger which in turn operates the rest of the mechanism. In the mechanical gun control the impulse of the cam is transmitted to the gun through a series of rods, causing the gun to fire at the exact moment when there is no propeller-blade in front of the muzzle. In the hydraulic type the impulse of the cam is transmitted to the gun through a system of copper tubes containing oil under high pressure. The hydraulic control, known as the Constantinisco, was adopted for use on American planes, particularly

the De Haviland 4, which carries two fixed Marlins, each firing at the rate of 650 shots a minute. By employing the maximum rate of fire, 1,300 shots could be fired in a minute through the blades of the propeller, which would make 1,600 revolutions in the same space of time—without the blades being struck by a single bullet.

A machine-gun intended for aerial use must be absolutely reliable in operation. If a gun jams on the ground there is usually time to overhaul it or to replace it. Not so in the air. There a jam or a malfunction is almost certain to prove disastrous, if not fatal, to the gunner, who is left completely at the mercy of his adversary. An aircraft gun must also function properly in any position in which it is likely to be placed by the manœuvres of the plane. Likewise, an intensely high rate of fire is essential. For groundwork 500 shots per minute is reckoned as sufficient for the machine-gun, for a higher rate of fire would only result in several bullets hitting the same man. But a considerably higher rate of fire—up to 1,000 shots a minute, in fact—is demanded of aircraft guns, this being necessitated by the great speed at which airplanes move. The gunner, remember, can train on his target for only a few seconds, sometimes for only a fraction of a second, at a time, and it is essential, therefore, that he should have at his command the greatest possible volume of fire. Do you appreciate that, were an airplane flying parallel to, say, a high board fence, at a speed of 100 miles an hour, and shooting at right angles at that fence with a gun firing

880 shots a minute, *the bullet-marks on the fence would be ten feet apart?*

Single-seater machines carry only fixed guns, which are mounted with the barrel parallel to the axis of the airplane. These guns, which are synchronized so as to shoot through the propeller, are put into action by a trigger on the "joy-stick" of the plane and are aimed by pointing the entire airplane at the enemy. Flexible guns are used only on two-place machines, being operated by the observer or gunner. They are carried on the Universal mount, which permits of the gun being pointed in any direction. All of the flexible aircraft guns used by the Allies were based on the principle of the Lewis gun, the invention of a retired American army officer, Colonel Isaac Lewis. The chief difference between the ground and aircraft models is that in the latter the cooling radiator is eliminated, as aircraft guns are never fired continuously for any length of time.

When the United States entered the war the Vickers was the only type of fixed gun in use on either English or French planes and was used on all the planes which General Pershing bought in France. When the Equipment Division of the Signal Corps faced the machine-gun situation in September, 1917, it was alarmed to find that the entire production of Vickers in the United States had already been contracted for to supply the imperative requirements of the infantry. There was another gun on the market at this time, however—the Marlin—and toward its development for aircraft use the officers of the Signal Corps bent

all their energies. Though the Marlin was adopted in the face of violent opposition, it resulted in providing sufficient fixed guns to arm the American planes, the wisdom of the action being proved by the fact that up to the time of the Armistice no other fixed guns were ready for delivery. The Marlin has been adapted to all American-built planes which carry fixed or synchronized guns, over 37,000 having been produced up to December, 1918. This gun shoots .30-calibre ammunition at the rate of 600 to 650 shots a minute and is fed from a belt of the disintegrating metal-link type. In December, 1917, the first order was placed for Lewis aircraft guns, over 39,000 of them being delivered to the American Air Service within the following twelvemonth. A notable improvement in the aircraft model of the Lewis gun was an increase in the depth of the magazine pan, so that each magazine holds 97 cartridges instead of 47 as previously. The Browning aircraft machine-gun was just coming into production when the war ended. This weapon embodies the best features of every known machine-gun and would probably have replaced all other types in use. It is a belt-fed gun of the recoil type—both the Marlin and Lewis are gas-operated—is as near fool-proof as a machine-gun can be made, and has the amazing rate of fire of 950 shots a minute. Of it the inventor is said to have remarked: "If it had four more parts it could play a tune; if it had seven more parts it could talk."

The ammunition for fixed aircraft guns, such as the Marlin and Browning, is carried in belts containing

a maximum of 500 rounds. In the earlier days of the war these belts were of woven web, but it was found that taking care of them, when empty, in the limited space of the fuselage, was always a source of annoyance and not infrequently a source of danger to the aviator. To remedy this a belt was designed and furnished to the American Expeditionary Forces which consisted of small metallic links held together by the cartridges themselves. As the gun fires, the links drop apart, chutes being provided so that they fall clear of the airplane. Another minor though interesting feature of aircraft armament is the small electric heater which is now provided for the purpose of keeping the gun warm and thus preventing the oil from congealing in high altitudes.

Efforts to make the bursts of fire from aircraft guns of maximum effectiveness have led to the development of three distinct types of ammunition—tracer, armor-piercing, and incendiary. The tracer type of ammunition was developed to assist the gunner in correcting his aim, and is equally useful by night or day, as the course of the bullet can be traced by a trail of white smoke in the daytime and by a bright spark at night. Armor-piercing ammunition has a projectile consisting of a hard steel core with a soft nickel casing. The object of this ammunition, as its name implies, is to pierce any of the metallic parts of an enemy plane, particularly the gasoline-tanks or the engine, the soft nickel casing acting as a lubricant and preventing the steel core from glancing off. Incendiary ammunition is loaded with yellow phosphorus. When the cartridge

is fired the rifling in the barrel of the machine-gun opens a small hole in the case of the projectile, thus permitting the phosphorus to come in contact with the air, whereupon it immediately ignites and sets fire to any inflammable part of a plane which it may hit. It is customary to load the belts or pans of aircraft machine-guns with these three types of special ammunition in a certain sequence, depending upon the notions of the pilot himself. A sequence commonly used was, first, the tracer cartridge, which assisted the gunner in correcting his aim; next, two or three armor-piercing cartridges, in the hope that they would pierce the enemy's gasoline-tank or damage his engine; and then one or two incendiary cartridges, which if the gasoline-tank was pierced would ignite the leaking gasoline and set fire to the machine. This sequence was continued throughout the loading of the belt or pan.

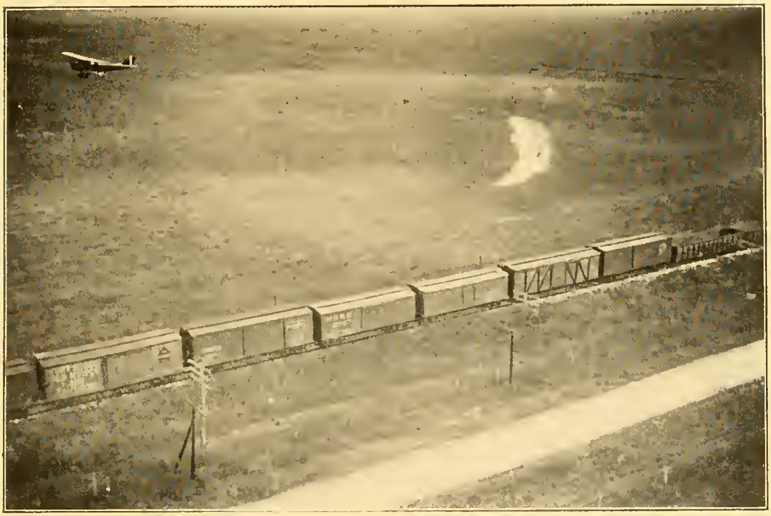
Another branch of sky warfare which was being rapidly developed was aerial bombing. Though bombs of a sort were used by Italian aviators against the Arabs during the Libyan campaign, and by American soldiers of fortune serving with the Villista forces in northern Mexico, these attempts were so amateurish and ineffective as to merit no serious consideration. It may be said that the first bombs dropped from an aircraft in the history of warfare were those loosed from the German Zeppelin which raided Antwerp in August, 1914. I speak with a certain personal knowledge of my subject, for the first bomb dropped on the night in question exploded less than a hundred yards

from the window in which I was sitting, demolishing a house and killing three persons.

Many people seem to be under the impression that bomb-dropping is about as simple as dropping a brick out of an upper-story window onto the head of a man beneath. This is not so. As a matter of fact, it is extremely difficult to drop a bomb from an airplane so that it will hit a desired target, for, owing to the speed at which the plane travels, the bomb when released does not drop to the ground vertically, but falls in a parabolic curve, something like that described by a man who jumps from a street-car when it is in motion. For this reason the bomb must be released some moments before the airplane is directly over the target, the ability of an aviator to determine the exact moment to pull his release mechanism being acquired only through long experience. Bomb-sights have recently been perfected, however, which have largely eliminated this element of chance. These sights have numerical scales mathematically calculated, so that when adjusted for height, air-speed as shown by the air-speed indicator, and calculated speed of the wind with or against the airplane, two sighting points are moved into such a position that if the bomb is dropped when the desired target comes in line with them, it will reach its objective—provided, of course, the aviator has made his calculations and set his sights correctly. All this sounds rather complicated, I know, and it *is* complicated, but if the pilot uses the sight correctly his chances of hitting his target are enormously increased. All bombing planes are fitted with

quick-release mechanisms, which hold the bombs firmly in a vertical or horizontal position, according to the type and size carried. On the smaller bombing planes, such as the De Haviland 4, the release mechanisms are placed underneath the fuselage or the lower wings, but on the large types, such as the Handley-Page, the bombs are carried inside the fuselage. By a quick jerk of a lever the pilot releases his bomb precisely as a hangman, by jerking a lever, drops the trap on which the condemned man stands. And the consequences are usually much the same in both cases.

There were three distinct types of bombs—demolition, fragmentation, and incendiary—in use by the American Air Service when the war ended. American demolition bombs are made in 50, 100, 250, 500, and 1,000 pound weights, the 100 and 250 pound sizes being used chiefly. These bombs consist of a light steel casing filled with T N T or other high explosive and a detonator separated from the explosive by a safety-pin. When the bomb is released from the airplane the safety-pin is automatically pulled out, permitting the detonator to slide down into such a position that the bomb will explode the instant it strikes the ground. These demolition bombs are primarily designed for use against buildings, fortifications, and other heavy structures where a high-explosive charge is desired. Had the war continued long enough to have permitted of our aviators letting loose a few 1,000-pound bombs on some of the trans-Rhine strongholds, the Germans would have learned what the San Francisco earthquake was like. Fragmentation bombs



Photograph by Signal Corps, U. S. A.

BOMBING PRACTICE.

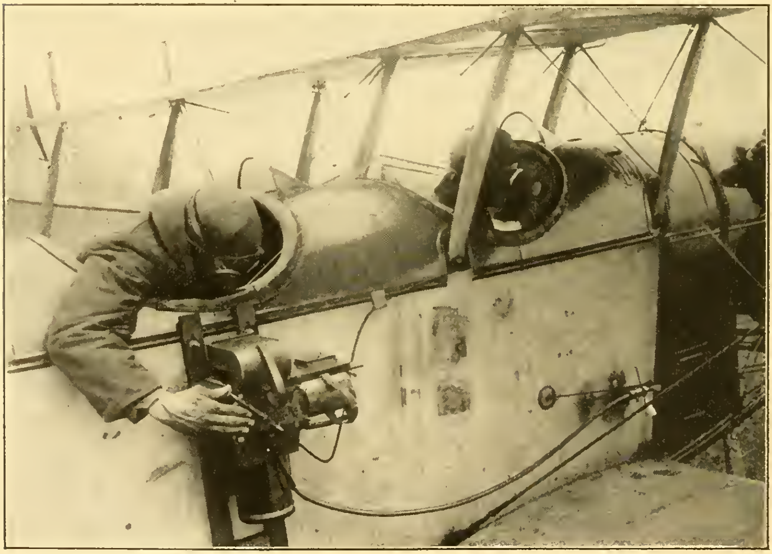
An illustration of how the enemy's lines of communication can be destroyed by bombs dropped from airplanes.

Photograph by Signal Corps, U. S. A.

EGGS OF DEATH.

Attaching dummy bombs to the rack of a bombing plane.

PIGEONS HAVE BEEN REPEATEDLY USED WITH SUCCESS FROM BOTH AIRPLANES AND BALLOONS.



Photograph by U. S. Air Service.

THE EYE IN THE SKY; AN AIRPLANE CAMERA IN OPERATION.

During the offensive in the Argonne the American Photographic Sections made 100,000 aerophotographs of battle lines in four days.

are considerably smaller, the size most frequently used weighing twenty pounds. They have a thicker case than the demolition bombs and are constructed so as to explode a few inches above the ground. These bombs are for use against troops in trenches or in the open and depend upon the scattering of the fragments for their effect. Incendiary bombs weigh about fifty pounds and contain charges of oil emulsion, thermite, and metallic sodium, which burn for several minutes with the intense heat of a plumber's blow-lamp. They are used against ammunition-depots, storehouses, and other structures of inflammable construction, the purpose of the metallic sodium being to discourage the efforts of any one who attempts to put out the fire, as it explodes violently when water is poured on it.

Comparatively few persons realize, I suppose, that fireworks almost identical with those we used to set off on the Fourth of July in the good old days before the safe-and-sane laws went into effect are utilized in aerial warfare and form a valuable and often vital asset for the aviator. Most of these aerial pyrotechnics resemble in their effects the colored lights and the Roman candles of our childhood and are used for signalling from the airplane to the ground and vice versa, or from one plane to others in the air at the same time. For this purpose every active service airplane carries one or more signalling pistols, depending upon the number of the crew. These rather formidable-appearing weapons, which look not unlike the big-barrelled affairs the pirates were wont to carry in their scarlet sashes, are similar to the Very pistols used in the

trenches; their ammunition consists of cartridges very similar to shotgun shells, but larger, containing stars of various colors, like those in Roman candles, and the necessary powder charge to eject the stars. Three colors, red, green, and white, are furnished, the color of the star being indicated on the base of the cartridge, which is also serrated in such a manner that the aviator can tell the color by touch when flying at night. By different combinations of these colors an almost endless variety of signals can be conveyed. One of the strangest and most fascinating night sights on the Western Front was to see these countless stars, scarlet, yellow, emerald, shot from invisible airplanes, drifting across the purple velvet of the sky. The stars are clearly visible in the daytime and were used for many purposes, such as indicating the position of enemy troops, the presence of hostile aircraft, requests for assistance from other planes, and as a means of transmitting orders from the leader of a squadron to other machines in formation. At night the signalling pistol is of exceptional value in aiding the aviator to effect a safe landing. When approaching his home-field the pilot fires a light of a prearranged color, and if answered by a light of a proper color from the ground, he knows that the field is clear of obstructions and other machines and safe to land on. Pilots have also used their signalling pistols for firing into their gasoline-tanks and thus setting fire to their machines when forced to land in enemy territory. There are also a few cases on record of the pilot being able to hold enemy soldiers at bay with his signalling pistol long enough to prevent them from extinguishing the fire.

Night-flying is one of the most hazardous duties of the aviator, the chief danger being in the difficulty of making a safe landing. Night-landing fields are, as a rule, well illuminated by flood-lights, but near the front this was not always advisable or safe, and, owing to the difficulty of judging the distance of the machine above the ground in the darkness, accidents were by no means uncommon. In order to minimize this danger there was developed the "wing-tip flare," which consists of a small cylinder of magnesium material in a metallic holder, one of which is fitted under each lower wing of the plane. The flares are ignited by an electric current and are controlled by push-buttons, one for each flare, in the pilot's cockpit. In making a night-landing, when the pilot judges the plane to be but a few feet above the ground, he presses one of the buttons. The flare instantly ignites and for about fifty seconds burns with a light of approximately 20,000 candle-power, which, reflected on the ground by the under surface of the wing, enables the pilot to judge his distance and effect his landing without trouble.

The requirements of night-bombing have led to the development of a new and very interesting form of pyrotechnic known as the "airplane flare." This flare, which weighs thirty-five pounds, is contained in a cylindrical case of sheet-iron about four feet long and five inches in diameter. The flare consists of an illuminating charge, capable of giving 32,000 candle-power for approximately ten minutes, which is attached to a silk parachute twenty feet in diameter. The

cylinder is attached to the airplane by a light release mechanism similar to those used for holding bombs. On the end of the cylinder is a small pinwheel, which, revolved by the rush of air as the released cylinder hurtles downward, ignites the illuminating charge and at the same time detonates a small black-powder charge sufficient to eject the flare and its tightly rolled parachute from the case. The parachute immediately opens and the burning flare descends very slowly, illuminating a large area of territory underneath almost as brightly as though it were day. These flares were used particularly for night-bombing raids, the pilots thus being enabled to illuminate the objectives so that they could accurately drop their bombs. On several occasions, when raiding airplanes were met by heavy fire from the enemy's antiaircraft batteries, it was found that the light from these flares was so dazzling as to make it impossible for the gunners to take accurate aim. So wide is the radius illuminated by these flares, and so intense their light, that it has been found possible by their aid to obtain aero photographs of excellent detail even on the darkest nights. I can personally vouch for the amazing brilliancy of these flares, for I saw one dropped by the Germans during one of their air-raids on Paris in the summer of 1918. It apparently landed on the Pont Alexandre III or in the Seine, yet both banks of the river, the façades of the Grand and the Petit Palais, and the Champ Elysées for several blocks in both directions were almost as bright as though illuminated by a midday sun. Standing alone in the Cours de la Reine, I had the

feeling that the Kaiser's eye was on me and that, having discovered me, he intended to drop upon me one of his steel visiting-cards. The brilliancy and unexpectedness of the glare reminded me of boyhood days in the Thousand Islands, when the captain of the *Island Wanderer*, making his nightly excursions amid the clustered, cottage-dotted isles, took keen delight in suddenly turning the beam of his powerful searchlight upon some affectionate pair love-making on the shore.

It has been said that the airplane is the eye of the army, and it is equally true that the camera is the eye of the airplane. Nothing more strikingly emphasizes the enormous importance attached to pictures taken from the air, showing the progress of the operations, than the fact that, during the offensive in the Argonne, the American photographic sections made *one hundred thousand aero photographs of the battle-lines in four days.*

As aerial photography was an entirely new military subject at the outbreak of the war in 1914, there were no precedents to act as guides, nor was there any special apparatus in existence. Consequently, the entire art of aerial photography was developed and brought to its present state of perfection by the Allies under the incentive of military necessity and after the war had begun. As trench warfare made aerial photography not only important but vital to the success of any proposed operations, the changes and improvements in the apparatus employed came with incredible

rapidity, practices employed one week becoming obsolete the next. By April, 1917, the British Air Service alone had issued approximately 280,000 prints, and this number was equalled, if not surpassed, by the French *Section Photographique.* At the beginning of the war it was possible to fly at low altitudes and secure reasonably satisfactory pictures with such cameras, plates, and lenses as were then available. But as anti-aircraft artillery was developed, the planes were forced to climb higher to keep out of their range, and owing to the necessity for longer-focus lenses, special plates, and color filters to overcome the haze existing between the camera and the earth, photography at these high altitudes became increasingly difficult.

When the United States entered the war the British, French, and Italians were using plates exclusively and we followed their lead, it not being until some months later that we turned to films. At this time the British were using 4 x 5 plates, and cameras equipped with lenses of from 8 to 12 inch focus. Instead of making contact prints from these negatives, enlargements 6½ x 8½ were made on glossy paper, it being claimed that this process gave greater control in printing. Whether the British system really had all the advantages claimed for it is open to question, but in any event we adopted it and followed it through the first nine months of the war. The great masters of photography in Rochester were by no means content to let another nation set the pace for the United States, however, and in January, 1918, a concern in that city completed a very remarkable aero camera,

radically different from anything which had been seen in Europe up to that time, which was promptly adopted by the War Department. This camera, which took an 18-cm. by 24-cm. picture, had a focal length of 20 inches, held a roll of film on which 100 successive exposures could be made, and weighed only 35 pounds. Its most novel feature was the "vacuum back," consisting of a perforated sheet which extended across the top of the chamber and over the face of which the film passed. A slight air-suction, produced by a Venturi tube placed where it would catch the rush of air past the plane, served to hold the film absolutely flat—for the slightest curvature of its surface would play havoc with the perspective of a picture taken from a height, say, of 10,000 feet. This ingenious instrument was driven by an electric motor which changed the film and automatically set the shutter, the observer having only to start the machinery going and regulate its speed according to the rate of travel of the airplane in order to obtain a series of pictures forming a continuous photograph of the territory over which the machine was passing.

Another picturesque phase of aerial photography of which the public was permitted to know next to nothing was the so-called "gun camera," the invention of Thornton Pickard, of Altringham, England. This camera, which was designed for the purpose of training aerial gunners, imitated as closely as possible a Marlin aircraft machine-gun, and in order to make a picture it was necessary for the operator to go through the same movements as in firing a Marlin gun. The picture

was made through a circular graticule synchronized with the sight on the fixed machine-gun, so if the film, upon being developed, showed that the gunner had scored a "hit" with the camera, he would have been equally successful with an actual machine-gun. The gun cameras as developed in the United States were of two kinds: one, using a regular Brownie film, took one picture each time the trigger was pulled; the other, which was virtually a motion-picture camera so constructed as to exactly replace the magazine on a Lewis gun, gave a "burst" of exposure with a rapidity equalling that of a machine-gun firing a burst of shots, and was used for training aviators in the handling of their flexibly mounted Lewis guns. The resulting film, or bromide print, consisted of a string of silhouettes of the supposed enemy plane, each with an image of the gun-sights superimposed to show where the gun was held, with reference to the target, at the instant the picture was taken.

The enormous numbers of pictures taken from the skies necessitated a corresponding development and manufacture of travelling dark rooms, seventy-five complete units of these machines being built and shipped overseas. These consisted of mobile photo laboratories, having all the equipment necessary for the rapid production of prints in the field, for when important operations are in progress it is imperative that the aero photographs reach the staff at the earliest possible moment after they are taken. The dark rooms, which were mounted on trucks, were equipped with apparatus for generating the current used in the

lamps and enlargers, while trailers were fitted with sinks, tanks, enlarging cameras, and other necessary photographic apparatus. The fact should not be overlooked, moreover, that provision had to be made for training the vast and for the most part inexperienced personnel of the photographic sections in the countless new and peculiar phases of taking pictures from the skies.

In considering the development of military aeronautics it must be borne in mind that the maximum altitudes attained by airplanes increased enormously during the war. In 1914 the record for altitude was 26,246 feet, or slightly less than five miles. By January, 1919, the record had been raised to 30,500 feet, an increase of more than four-fifths of a mile. In 1915 the Western Front pilots worked at 7,000 feet without fear of attack from the ground, and few machines flew at heights of more than 10,000 feet. In fact, the "ceiling" with the early equipment was about 12,000 feet. In the closing months of the war, however, as a result of the development of the antiaircraft artillery, it became necessary for aviators to climb to 15,000 feet over the enemy lines, and tactics of the air made that machine safest which could fly highest.

Now it may not have occurred to you that the higher you ascend the greater becomes the decrease in atmospheric pressure. At 19,000 feet the pressure of the atmosphere is one-half the pressure at sea-level. That means that a given amount of air in the lungs of an aviator flying at that height gives only half the oxygen that it would were he on the ground. It is,

then, the lack of oxygen, and not, as many suppose, the low pressure itself, which makes men weak and slow of action at high altitudes. Though these facts have been determined by medical research, it is a curious phase of the flyer's psychology that most aviators laugh at the idea. Yet any one who has crossed the Rockies or ascended one of the Alpine peaks by funicular has noticed that as the altitude increases the breathing becomes quicker and deeper, the heart beats faster and faster. But though the pilot may, as he asserts, continue to feel perfectly fit and well, he is not as efficient as when near the ground. His reactions become slower, he is less prompt to judge distances, to aim his guns, to fire, to manœuvre his plane —and this despite the fact that he is usually quite unconscious of any impairment of his faculties. He will feel dizzy but perfectly happy—autointoxication, I believe the doctors call it—whereas, as a matter of fact, he has lost his judgment; and if he attempts to stay at these altitudes he will gradually pass into a condition of partial and sometimes total unconsciousness, lose control of his machine, and come crashing to the earth.

The imperative necessity of maintaining flyers at the highest possible efficiency was brought home to the aviation authorities through studying the reports of English air-casualties during the first year of the war. The records divided these as follows: 2 per cent were due to the enemy, 8 per cent were due to the plane, and 90 per cent were due to the men, which clearly indicated that something was radically wrong

with the personnel and that prompt action was necessary. A thorough study of the situation disclosed the fact that practically all of the flying personnel was suffering from what is known to scientists as oxygen fatigue, caused by flying for many hours a day at high altitudes where there was not enough oxygen to feed the body. As a result of this discovery, Lieutenant-Colonel Dreyer, of the Royal Army Medical Corps, designed an oxygen apparatus for use by the British air forces, the manufacture of which was immediately begun in Paris. So pressing was the need for these apparatus that an automobile was kept waiting at the plant where they were being manufactured to rush each one to the front as soon as it was finished.

An original model of this apparatus was brought to the United States shortly after we entered the war, but as it was made entirely by hand, it had to be redesigned to meet our manufacturing conditions. The perfected oxygen equipment, as used in the American Air Service, consists of a small tank, or tanks, according to the amount of oxygen carried, a pressure device, a face-mask covering the mouth and nose, and a tube connecting the mask with the oxygen reservoir. The American mask has combined with it the interphone whereby the pilot and observer can converse with each other while in the air and, in certain cases, the receiver of the radio telephone. In May, 1918, six complete apparatus were sent overseas by special messenger to be tried out under battle conditions, and when the war ended 5,000 had been manufactured and accepted. All American military planes flying at an

altitude of over 10,000 feet are now fitted for the installation of oxygen equipment. This includes day-bombing, pursuit, and chase planes, and a percentage of night-bombing and observation machines. So much importance was attached by the military authorities to supplying our flying-men with oxygen that a special oxygen division was organized and sent to France for the purpose of installing the apparatus in the planes. Yet, as I have previously remarked, the flyers themselves persist in regarding the apparatus, probably because of the discomfort involved in wearing it, with amused scepticism.

Of all the inventions which have sprung from the war, none is more amazing, to my way of thinking, than the radio telephone. Think of standing on the ground and holding a conversation in a normal tone of voice with an aviator so high in the sky that you cannot see his airplane with the naked eye. Think of it! Before we entered the war, any one save a handful of enthusiastic scientists would have ridiculed such a suggestion, yet to-day, at any one of a score of flying-fields, you can sit at an office desk and converse with aviators in the clouds as easily as though you were sitting opposite them at a dinner-table.

The enormous advantage which such an invention would give to the army possessing it was early recognized by certain electrical engineers and a few scientifically minded officers of the Signal Corps, and, as a result of their enthusiasm, before the first contingent sailed for France work had been begun on the develop-

Photograph by Signal Corps, U. S. A.

RADIO TELEPHONE APPARATUS IN OPERATION ON AN AIRPLANE.

The pilot and observer are able to talk to each other through the same instrument by means of which they communicate with the ground.

Photograph by Signal Corps, U. S. A.

PRESIDENT WILSON TALKING WITH AN AVIATOR IN THE CLOUDS BY MEANS OF THE RADIO TELEPHONE.

A RANGE-FINDER FOR ASCERTAINING THE ALTITUDE AND SPEED OF AIRPLANES.

One of the most remarkable inventions of the war. This instrument not only ascertains the altitude and position of an airplane but by means of an electric connection automatically sets the sights on the anti-aircraft gun.

ment of a radio-telephone set for airplanes. There is no necessity of recounting the innumerable experiments and heart-breaking failures before the first real successes were obtained. So far as the radio part of the problem was concerned, a solution was had in a comparatively short time. But working this apparatus in a swift-moving and terrifically noisy airplane was quite a different matter, it was quickly discovered, from working it under ordinary conditions on the ground, the roar of the engine and the rushing air making it impossible to hear one's own voice, much less the weak signals of the receiver. One of the first problems to be solved, therefore, was to design a head-set which would exclude these noises while at the same time permitting the voice of the telephone to be heard. The answer was found in a form of aviator's helmet fitting the head so closely as to exclude virtually all extraneous sounds save those coming through telephone-receivers inserted in the helmet so as to fit the ears. No sooner was this problem solved, however, than another one demanded solution. A means had been devised for protecting the receivers from outside noises—but how about the *transmitter?* Every one knows how sensitive the ordinary telephone-transmitter is to extraneous sounds, so it does not require much imagination to picture how impossible it would be for the aviator to make his voice heard in a transmitter alongside a 200 horse-power airplane engine. But a brilliant series of experiments, conducted largely by Mr. J. P. Minton, of the Western Electric Company, resulted in a form of telephone-transmitter or microphone which

possessed the remarkable quality of being insensible to engine and wind noises and at the same time highly responsive to the tones of the voice. With these two elements in hand it was thought that the problem was solved, but three more months of unremitting work were required to perfect the apparatus to a state where it was practicable for use by others than experts. At last everything was ready, however, and in December, 1917, the officials of the Aircraft Production Board and the joint Army and Navy Technical Boards announced that they would witness an exhibition of the apparatus at the Moraine Flying-Field at Dayton. Two days before the date set for the demonstration a group of the engineers and mechanics who had been working over the problem almost night and day during the preceding six months descended, with many cases of paraphernalia, on the Ohio town. Only the enthusiasts who for the preceding half-year had spent their days working over the problem and their nights dreaming of it believed that the exhibition would prove successful. Every one else was sceptical. The plan was to have two planes, both carrying radio sets, in the air at the same time, while the visiting officials listened in at a ground-station located on the top of a near-by hill. That night the inventors and their assistants congregated in a room of the hotel where they were staying and worked out a scenario and held a rehearsal of the morrow's programme. A famous electrical expert represented one plane and a young engineer represented the other, while the inventors, sitting in the middle of the room,

gave them their orders and sent them sailing over beds, chairs, and tables as it was hoped their planes would manœuvre in the clouds the next day. No one slept very well that night. The morning was cold and dismal, in keeping with the spirits of all concerned. Upon the arrival of the exalted ones, among whom were several of the foremost scientists and inventors of America, they were shown the apparatus installed in the two planes and were told what it was expected to do. They were then escorted up to the little station on the hill, where a loud-speaking receiver had been connected with the wireless apparatus, so that all could hear without the use of head-sets. The planes left the ground, and after what seemed an interminable length of time, there came from the receiver the first faint sounds which indicated that they were ready to perform. The officials, with their coat-collars about their ears, appeared only mildly interested and several gave unmistakable signs of being bored. Suddenly, without the slightest warning, out of the horn of the loud-speaker came the words: "*Hello, ground-station! This is Plane Number One speaking. Do you get me all right?*" The bored expressions on the faces of the officials changed to expressions of amazement tinged with awe. Instead of the confusing dash-dot-dash which they associated with wireless, here was a human voice coming out of space clear and distinct—yet the speaker was two miles in the air. Soon the same signal came from the other plane and the exhibition was on. Under command from the ground the planes were manœuvred all over that part of the coun-

try. They climbed and volplaned and circled. They were sent on scouting expeditions and reported what they saw as they travelled through the air. Continuous conversation was carried on, even when the planes were out of sight, and finally, upon command, they came tearing down the skies like two huge homing pigeons and landed where directed. From that moment the radio telephone was sold to the government. It was no longer a question as to whether it would work, but how soon and in what quantity its manufacture could be started.

The primary object of the airplane telephone is to make it possible for the commander of an air-squadron to control the movement of his men in the air just as a drill-sergeant directs the evolutions of a platoon on the ground. For this purpose extra-long range is not required or, indeed, desired, the distance over which they can talk being purposely limited to two or three miles, so that the enemy cannot overhear except when actually engaged in combat. Then it does not matter.

Neither my space nor my knowledge of electrical engineering are sufficient to permit of explaining in detail the working of the radio telephone. It is enough to say that a wind-driven generator supplies electric current to a couple of vacuum tubes mounted in a box filled with coils and condensers. These tubes transform the dynamo current into a high-frequency alternating current which is fed out into space through the antenna. This antenna consists of a copper wire about 200 feet long, which with a lead weight on the end trails out behind the airplane when it is in flight.

Normally this wire is wound up on a reel, being let out and wound in as occasion demands. With the special form of telephone-transmitter already described, the words of the aviator are impressed on this wire, the electric waves thus set in motion radiating out into space, where they are picked up by similar antennæ either on other planes or on masts on the ground. The receiving process is the exact reverse of that used in sending, other vacuum tubes taking the high-frequency current from the antenna and transforming it so that it can be heard in the form of speech in the telephone fitted in the aviator's helmet or in the loud-speaking horn on the ground. That is about as near as I can come to explaining the radio telephone without writing a book.

One of boyhood's most joyous recollections is that of "balloon day" at the county fair, when the great yellow spheroid in the middle of the race-track enclosure slowly filled (oh, so slowly, it seemed!), bulged, tugged at its moorings, and at last rose majestically skyward, the aeronaut, a lithe figure in spangled tights, waving down to the sea of upturned faces as he swung at ease in his cobweb-like trapeze. But, though the recollection of the balloonist's skill and daring remains sharp and clear in our minds, so much space has been devoted in the war books and the news despatches to the exploits of the aviators that we seem to have completely lost sight of the no less hazardous work of those daring souls who, day after day, in heat and cold, in snow and drenching rain, sat huddled in their

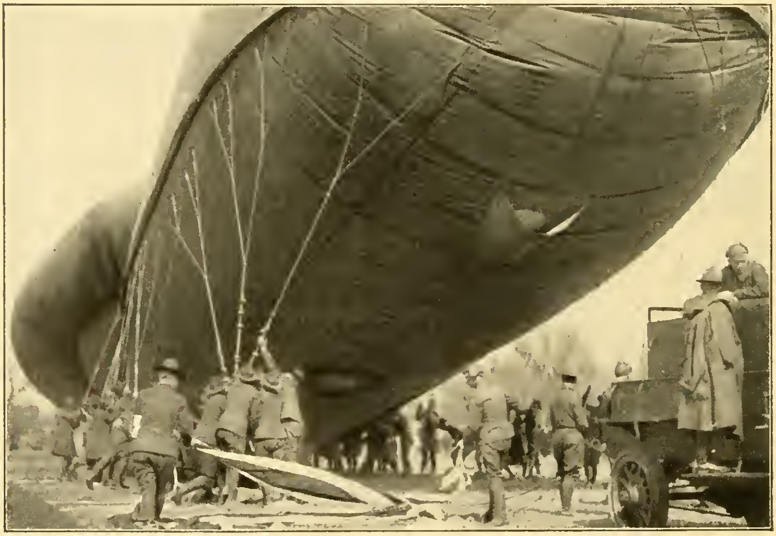
frail baskets under the swaying gas-bags, often a mile above the ground, and through their glasses watched what the enemy was doing, heedless of the repeated attempts made by the enemy's gunners and flyers to bring them down. Though they have received practically no share of the publicity and praise which has been showered upon the flying-men, the officers and men of the Balloon Section of the Air Service deserve from the public its deepest gratitude and appreciation. The perilous nature of their work is shown by the fact that in the last six weeks of the war twenty-one American balloons were lost, six being destroyed by shell-fire and fifteen by enemy planes. Its importance is emphasized by the fact that the Germans gave official credit to their aviators of *one and a half planes for every balloon brought down.*

At the beginning of the war the artillery-fire of the Allies was directed for the most part by airplanes. Their work, however, left much to be desired. Though the plane observers could locate targets fairly well, they frequently lost touch with their batteries through the difficulty of sending and receiving wireless or visual signals from the swiftly moving craft. Thus there came into use the captive balloon, which by the end of the war had practically replaced the airplane as a director of gun-fire wherever possible, thus making the artillery infinitely more efficient than ever before. Sitting comfortably aloft, the observer in the basket of a kite-balloon had the whole panorama of his particular station spread beneath him like a map in bas-relief, being able to detect, with the aid of powerful glasses,

A SENTINEL OF THE SKIES.

Those daring souls who day after day sat huddled in their frail baskets and through their glasses watched what the enemy was doing.

AN AMERICAN OBSERVATION BALLOON LEAVING ITS "BED" BEHIND THE WESTERN FRONT.



Photograph by U. S. Air Service.

A BALLOON COMPANY MANŒUVRING A CAQUOT FROM WINCH POSITION TO ITS BED.

anything transpiring within a radius of ten miles or more. He was constantly in touch with his batteries by telephone and could not only give the gunners, by means of co-ordinated maps, the exact location of their target and the effect of their bursting shells, but could keep the staff informed of enemy troop movements, airplane activities, and preparations for impending attacks. The balloonist became, indeed, a veritable sentinel of the skies, hovering over the battle-lines with the persistency and the keen, long-range vision of a hawk. He played a less spectacular part in the great drama than the airplane scout or fighter in the latter's free and dazzling flights, but his duties were scarcely less important. Nor did he suffer from ennui during his stays aloft. When a kite-balloon went up along the battle-front it at once became the subject of the keenest attention by the enemy because it was known to be up on business and was certain to be the cause of damage unless it was forced down. Long-range, high-velocity guns were trained on it and, from the upper levels of the air, planes came swooping down upon it in their attempts to dash through the screen of shells from the antiaircraft guns and put an incendiary bullet into the sausage-shaped, elephant-colored gas-bag which so insolently defied them. And a bullet which got home meant the instant ignition of the highly inflammable hydrogen, the quick destruction of the balloon and, perhaps, the occupants of the basket as well, unless they could get away in their parachute. From the moment the gas leaped into flame until the fall of the balloon was rarely over fifteen or twenty

seconds, so quick thinking and quick work was called for if the men in the basket were to jump to safety. The pilot of the airplane could dodge and swerve and slip away from the guns by a hundred shrewd devices; not so the pilot of the kite-balloon anchored to its windlass. He had to carry on his abstruse mathematical calculations unconcernedly, his spare moments being enlivened by watching the flash of an enemy gun on a distant hill and then waiting twenty or thirty seconds for the whining messenger of death to reach him, pondering, meanwhile, on the accuracy of that particular gunner. As a matter of fact, few direct shell-hits on a balloon were recorded during the war, most of the balloons which were brought down having been accounted for by incendiary bullets from diving planes. Just as some sportsmen devote their energies to moose and elk and grizzlies while others specialize on smaller game, so some of the airplane pilots made a specialty of hunting "sausages," and at this thrilling and highly perilous sport became amazingly expert. When the Crown Prince's assaults on Verdun were at their height, I saw eight French aviators start out to bring down eight German balloons. Within less than thirty minutes seven of the *drachen* had come down in flames—which shows that a balloonist was not a good life-insurance risk. The average life of an observation balloon on the Western Front was estimated to be about fifteen days. Sometimes it lasted only a few minutes. There is a record of an American balloon passing unscathed through the whole period of American activity on a busy sector, but it was generally con-

sidered that a balloon which has seen five or six months of ordinary non-war service has done its duty and is unsafe because of the deterioration of the fabric.

In August, 1914, Germany had perhaps a hundred kite or "sausage" balloons, France and England a very few. The German type was known as the "Drachen," and consisted of a gas-cylinder of rubberized cloth about sixty-five feet long and twenty-seven feet in diameter, with hemispherical ends. For stability a lobe, about a third of the diameter of the cylinder, was attached to the underbody of the gas-bag and curved up around the end. This lobe, made of a lighter fabric than the bag itself, automatically filled with air as the balloon ascended and acted as a rudder to hold the balloon in line. For further stability three tail-cups, one behind the other, with mouths open to the wind, were attached to the rear of the balloon.

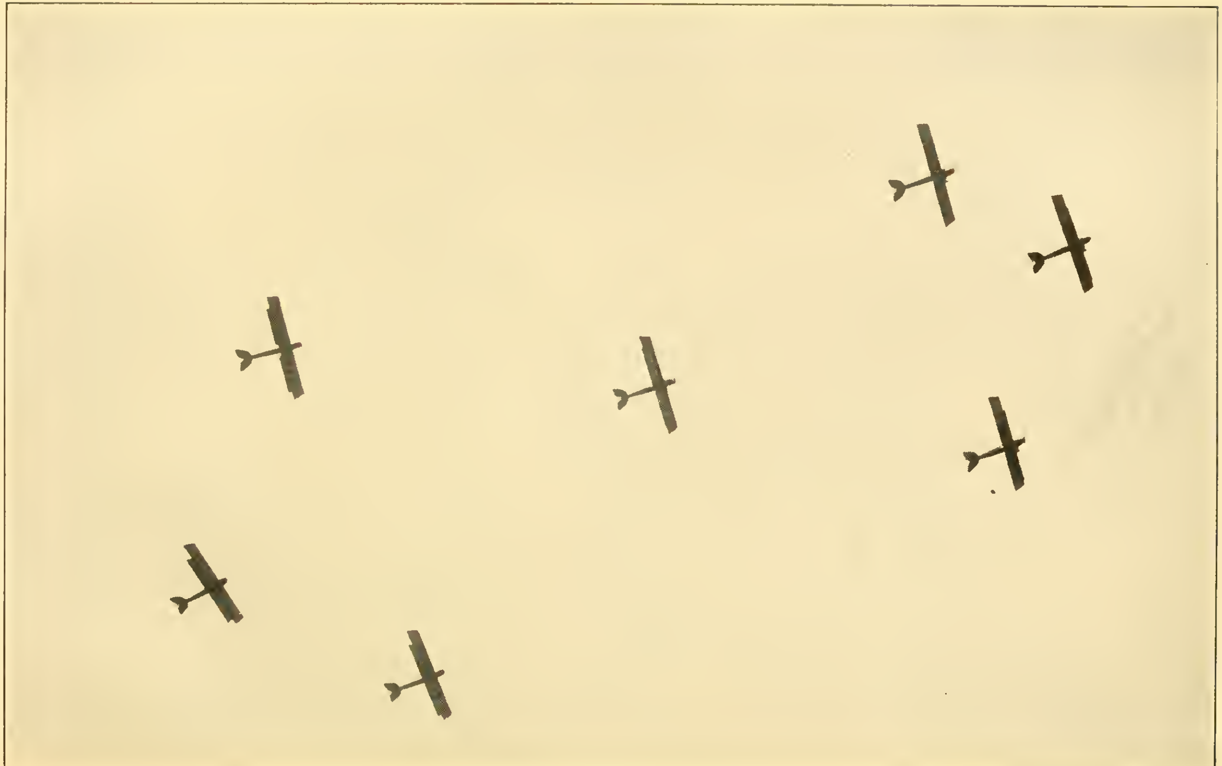
While the Drachen balloon was a rather clumsy affair and proved unstable in high winds, its importance as an adjunct to the artillery was early recognized by the Allies, for the results of its work daily became more apparent. Though the armies of France, England, Italy, and the United States made repeated experiments in an attempt to evolve a type which should possess greater stability and permit of higher altitudes being attained, it remained for Captain Caquot, of the French Army, to produce a balloon which possessed both of these qualities, his name now being used as a designation for the type which he invented and which was in general used by the Allied armies during the last year of the war. The Caquot received its greatest

compliment from Germany when her army adopted this type of balloon and discarded the Drachen.

The Caquot is an elongated gas-bag, ninety-three feet long and twenty-eight feet in its widest diameter, made of rubberized cotton cloth and sharply stream-lined. Hydrogen gas is the ascensive power used, lifting the cable, two men, basket, and all other equipment to a maximum altitude, in the best weather conditions, of over 5,000 feet. It has a balloonet, or air-chamber, within the main body of the gas-envelope, which as the balloon ascends fills automatically with air through a simple scoop placed under the nose of the balloon. The air and gas chambers are separated by a diaphragm of cloth. When the balloon is fully inflated this diaphragm rests on the underbody of the gas-envelope, there being no air in the balloonet. When the balloon descends, minus the several hundred feet of hydrogen which has escaped into the air, it would lose its shape and grow flabby, a condition of considerable potential danger, were it not for the balloonet, or air-chamber, coming into play. As the air is driven in through the scoop, precisely as an air-scoop fixed in the port-hole of an ocean liner brings air into a cabin, the diaphragm rises and takes up the lost bulk in the gas-envelope above. In other words, the escaping gas is replaced by air by means of what amounts to an elastic air-envelope below the gas-envelope. Is that quite clear? Three lobes of rubberized fabric give stability to the balloon. They are filled automatically by the wind, if it blows, and, expanding to their full capacity, act as rudders to hold the balloon steady. If

AN AMERICAN KITE BALLOON ABOUT TO ASCEND.

The lobes of rubberized fabric give stability to the balloon. They are filled automatically by the wind, if it blows, and, expanding to their full capacity, act as rudders to hold the balloon steady.



PLANES IN BATTLE FORMATION.

As accurately spaced as the pips on a card; as picturesque as a flock of geese southwardly bound.

there is no wind there is, of course, no need for the lobes and they hang loosely, like elephants' ears, Caquots frequently being called "elephants" because of these drooping lobes.

When the United States entered the war we were practically without this type of aircraft, the only balloon possessed by our military forces on the Mexican border having been the gift of an Akron rubber company to the Ohio National Guard. In April, 1917, the whole production of military balloons in the United States was not over two or three a month, but at the request of the government the various rubber manufacturers went whole-heartedly into the business of production, so that when the war ended we were producing ten balloons a day. Up to November 11 there had been produced for the United States Army alone 1,025 balloons of all types, 642 of these being the final Type R Observation Balloon. Propaganda and target balloons were likewise developed and produced, as were new-type parachutes, canvas balloon hangars, and 1,221,582 feet of steel cable—a sufficient length of single-strand, specially manufactured wire to more than reach around the globe.

One of the chief difficulties which had to be overcome was the question of a sufficient supply of cotton cloth of proper strength and texture, for balloon cloth was practically unknown in this country when we entered the war. In order to keep up with the balloon schedule of the War Department, the manufacturers required millions of yards of a very high-grade cloth with a weave of 140 threads to the inch both ways.

At first the wastage due to imperfect balloon cloth was enormous, frequently running as high as 60 per cent, but by care and effort this was reduced to perhaps 10 per cent in total from the loom to the balloon. The wastage was largely caused by "slubs," knots, and other imperfections of weaving, which prevented an even surface for rubberizing and consequently impaired the strength and gas-holding qualities of the cloth. Hundreds of inspectors, both factory and government employees, were necessary to get an approximately perfect fabric, and all had to be developed for this work. Indeed, the making of balloon cloth in the United States amounted to the development of an entirely new industry, for which thousands of men had to be specially trained for months. It will give you a better conception of the magnitude of this new industry, perhaps, when I tell you that to make ten balloons a day it was necessary for the cotton-mills to weave about 600,000 yards of this special balloon cloth a month, and this required 3,200 looms. It is a tribute to the skill of the American weavers that reports from the front stated that the American fabric burnt very much more slowly than that made in Europe, thus giving the observer more time to get away in his parachute and minimizing the danger of the burning balloon falling on him.

Everything connected with the kite-balloon presented more or less of a problem because it was new. The mobile windlass, for example, by which the balloon was let up and pulled down on its cable, had to be developed from nothing. But the genius of the Ameri-

can manufacturer overcame this difficulty as it did every other in the manufacture of instruments for war. Though steam was the motive power first used for balloon windlasses, before the close of the war American ingenuity had developed both gas and electric windlasses which were thoroughly efficient. The mobile windlass could move on the road under its own power at a speed of twenty miles an hour, and could tow a balloon in the air at the rate of five miles an hour, or even better if necessity demanded. The gasoline windlass has made a record pull-down of 1,600 feet a minute, bringing down its balloon at a speed more than *three times that of the fastest passenger-elevator.*

A sufficient supply of hydrogen gas was, at the beginning, another of the balloon problems. Hydrogen, before the war, was a by-product in the manufacture of commercial oxygen, and only a small quantity was used in this country. But the sudden demand for millions of cubic feet of this gas was promptly met by the establishment of government plants and the expansion of privately owned ones. Though by far the greater part of the gas used in balloons at home and abroad was made at permanent supply stations and shipped to the points where it was needed, in steel cylinders, an extremely ingenious type of portable generator was developed for the manufacture of hydrogen in the field. When these portable hydrogen generators were unnecessary or unavailable, the gas shipped from long distances was stored in high-pressure cylinders or "nurse balloons," the latter being simply huge bags of rubberized fabric, each with a capacity of 5,000 cubic

feet of hydrogen, which were used in the same way as the ordinary steel gasometers to be seen in any American city.

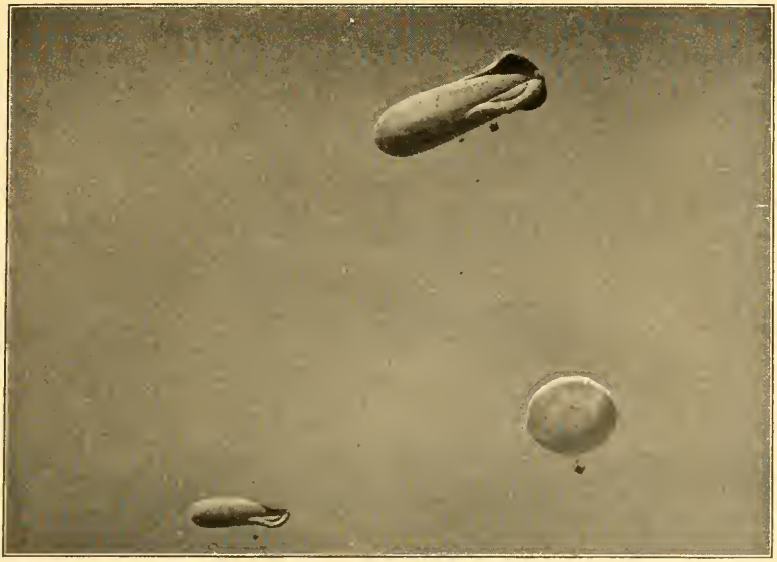
Hydrogen is itself an inflammable gas, and when mixed with air or oxygen is dangerously explosive. It has, therefore, always been a source of great concern to balloonists, who had long dreamed of a non-inflammable, non-explosive gas, sufficiently light to function as does hydrogen. It was known that helium was such a gas, but it was, until very recently, so scarce and costly that its use in balloons had scarcely been given a serious thought. Not more than 100 cubic feet of helium had ever been produced up to the time we started our balloon programme, and it was valued at $1,700 a cubic foot. Scientific investigators in the employ of the government discovered about this time, however, that certain natural gases in the United States contained limited quantities of helium, and the problem then resolved itself into one of extracting the helium from these gases in sufficient quantities, and at a sufficiently low cost, to make practical its use. Funds were forthcoming and, under the supervision of the Navy Department and the Bureau of Mines, the process of gas liquefaction was put into operation, with the result that on the day of the Armistice there were on the docks, ready for shipment overseas, 147,000 cubic feet of helium with a pre-war value of a quarter of a billion dollars. Plants were under construction which, had the war continued, would have produced 50,000 cubic feet of this gas a day at a cost of approximately ten cents per cubic foot. The importance of this dis-

covery cannot be overestimated, for it marks the opening of a new era in lighter-than-airship navigation. In war it will make the incendiary bullet, which has caused the destruction of countless balloons, a joke. The only way to bring down a balloon filled with helium will be literally to tear it apart by a direct hit with a high-explosive shell. Under peace conditions, it opens up undreamed-of possibilities in the development of new types of dirigible airships, as the danger from lightning, static electricity, and sparks of any kind has been entirely eliminated. To cross the Atlantic in a helium-filled balloon will be safer, so far as danger from fire is concerned, than to cross the continent in a train.

Do you remember that hot September afternoon at the county fair when you sat perched on the white-washed race-track fence, your face turned skyward, and watched with fascinated eyes the tiny yellow globule, high, high in the blue, which you had seen rise from the ground half an hour before as a giant gas-balloon? And do you remember how, as you watched, the band in the grand stand suddenly stopped playing and an awed hush fell upon the crowd, and you saw a tiny something detach itself from the yellow globule and drop into space, at first falling with sickening speed, then slower, still slower, until the object, which you knew was a man in pink tights (though sometimes, in order to heighten the sensation, it was a young and, of course, beautiful woman), landed quite gently in a distant field? In those days we little dreamed that

the strange, umbrella-like contrivance which brought the aeronaut safely to earth would ever be used for any other purpose than to thrill the admission-paying multitudes, but the emergencies and necessities provoked by the Great War turned things with which we were all familiar to unfamiliar uses, as, for example, when it converted a farm tractor into a fighting-tank. Thus it was that the observers came to use parachutes to escape from their burning balloons just as the inmates of an office-building dash down the iron fire-escapes when somebody shouts "Fire!"

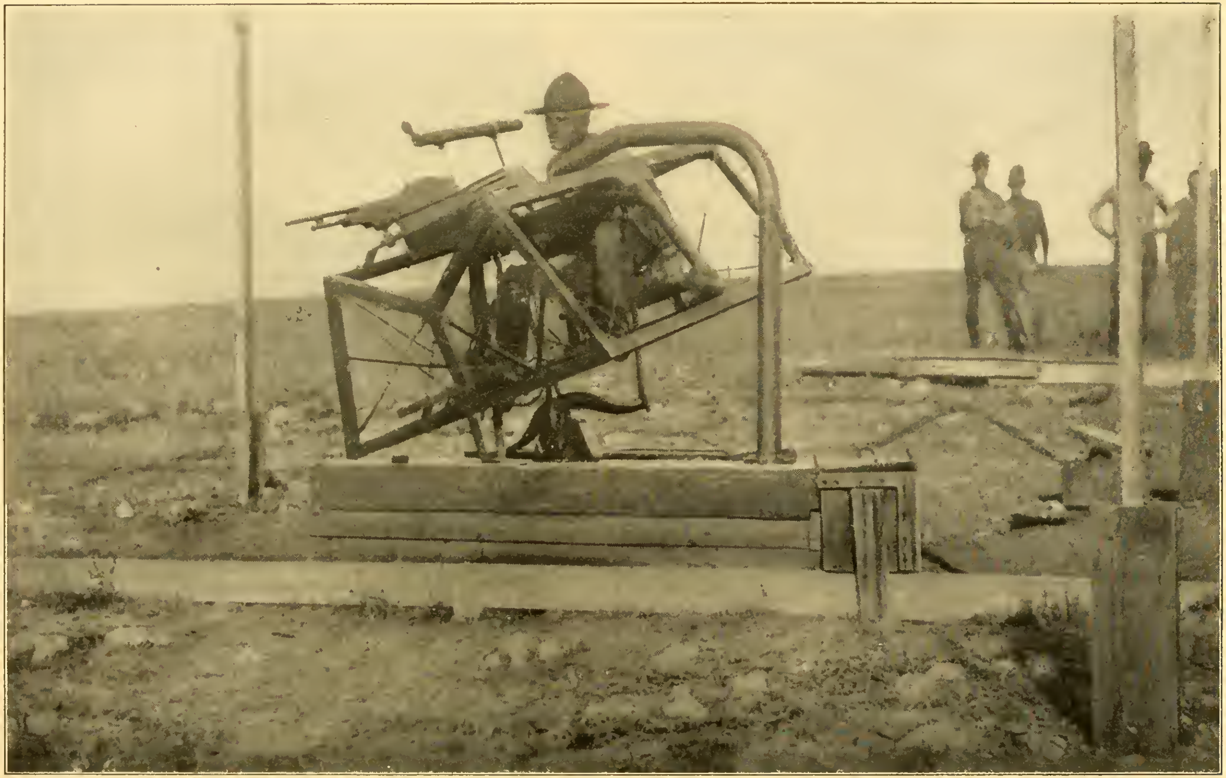
At first the individual or one-man parachute was used to insure the escape of the observer in the basket from his burning balloon, but though the man escaped, the valuable maps and records were lost. In order to save these records there was invented the basket parachute. This was considerably larger in diameter than the individual parachute, and when cut away brought the basket with all that it contained—men, records, instruments, everything—safely and quickly to the ground. All the observer had to do was to pull a cord and he started downward. It was easier than stepping into an elevator and saying: "Ground floor, please." Amazingly few fatalities occurred in the hundreds of cases in which the individual and basket parachutes were used in actual war service or in training. I heard of one balloon observer who was forced to make four parachute jumps in a single day, and of another who made three in four hours, two balloons being burned over his head. Thirty parachute jumps were made by American observers during the Argonne



A BASKET PARACHUTE DROP.

The basket parachute brings men, instrument, and records safely to the ground.

BALLOONIST MAKING A PARACHUTE JUMP FROM AN ALTITUDE OF 7,900 FEET.



TRAINING THE STUDENT AVIATOR.

"By means of a machine known as the Ruggles 'Orientator,' he could, while on the ground, be put through every possible evolution experienced in actual flying."

offensive alone. Yet the safety of the parachute is demonstrated beyond all question by the fact that during the entire time the American forces were in the field only one death occurred as the direct result of a parachute drop, and in that particular instance the burning balloon fell directly on top of the open parachute, setting it on fire and allowing the observer to fall the rest of the distance to the earth.

It is interesting to note that the use of parachutes is relatively new compared even with ballooning. The man who developed the parachute and who first descended safely to earth by its means—Thomas S. Baldwin—now holds a major's commission in the American Air Service, and during the war had direct charge of the inspection of all army balloons and parachutes. As the result of a life spent in performing aerial exploits of all kinds, under all conditions and in all parts of the world, Major Baldwin knows what is and what is not safe, so that when a balloon or parachute was sent into action the observer always had the satisfaction of knowing that the world's most famous balloonist had given it his O. K.

Speaking of parachute jumps reminds me of an incident which actually occurred on one of the American sectors toward the close of the war. Despite the fact that only one American balloonist lost his life in making a parachute jump—and in that case the fatality was caused by the burning balloon falling on and setting fire to the parachute—a very considerable element of risk is involved in the performance. In

fact, it became the custom to recommend a man making a parachute jump for the Distinguished Service Cross, or, if he was operating with the French, for the Croix de Guerre.

Just before the opening of the Argonne offensive an observation balloon over the American lines was attacked by a German plane and sent down in flames, the observer escaping by means of his parachute.

"You'll get the D. S. C. all right," his friends greeted him, as he disentangled himself from the parachute harness.

"We're sending up another balloon in a few minutes," said the commanding officer. "Want to try it again?"

"Surest thing you know, sir," replied the grinning youngster.

But before the second balloon had been in the air an hour another enemy plane swooped down upon it, like a hawk on a chicken-yard, and it too burst into flame. Again the observer floated to safety beneath his parachute.

"I guess I've got that D. S. C. copper-riveted this time," he remarked; but, when a third balloon ascended, he was in the basket. Once more a German plane came tearing down the skies, a stream of bullets ripped the silken gas-bag, and for the third time that day the observer reached the earth by the parachute route.

"You'll probably get the Croix de Guerre as well as the D. S. C.," his friends assured him. "The French are strong for this sort of thing. They may even give you the Legion of Honor."

Treading on air, the youngster returned to balloon headquarters. Tacked on the bulletin-board in the hallway was a General Order. He paused to glance at it. This is what he read:

"It is hereby directed that the custom of recommending officers making parachute jumps for the Distinguished Service Cross or other decorations be discontinued."

Though the question of providing proper clothing for our flying-men and balloon observers did not loom large when compared with the vast problems involved in the production of engines, spruce, balloon cloth, bombs, and machine-guns, it was nevertheless an exceedingly important one, for an aviator cannot do his work if he is cold, and it is always bitterly cold in the higher air-lanes. A man flying at 20,000 feet, say, suffers more from the cold than he would on the ice-fields at the North Pole. Aviators are commissioned officers, and when not at work wear the regular uniform, which, as in the case of all officers, is furnished by the officer himself. But the clothing required for work in the air, being of a highly special character and very expensive, is loaned to the flyers by the government. In view of this, it is a source of satisfaction to know that it was frankly admitted on the front that our flyers were by far the best and most efficiently equipped of any nation.

After many tests and much development, the following outfit was devised: On the head was worn, in moderate weather, first a woollen hood, or helmet, so designed as to fit closely over the entire head and

shoulders. In extremely cold weather, or for high-flight work, there was worn a silk hood of like design and double thickness, having between its layers an electrically heated unit connected by copper-wire cables extending through the suit proper with the generator on the engine of the plane. Over this silk hood was worn a soft-leather helmet lined with fur, the face was entirely covered with a wool-lined leather mask, and the eyes were protected by goggles. When it was necessary for the aviator to use the radiotelephone, however, the fur-lined helmet was replaced by the radio helmet, a leather affair somewhat similar in design to the other but so fashioned as to contain the receivers of a wireless telephone. For high-flight work, in addition to the above equipment, a rubber oxygen mask, which contained a transmitter permitting the wearer to speak as well as hear by wireless, was also worn. This mask was attached by a flexible tube to a tank of oxygen carried in the plane, being so arranged that it automatically fed the aviator with the amount of oxygen required for the altitude at which he was flying.

Over the body was worn a one-piece flying suit of waterproof, airproof material, reaching from throat to feet, buttoned tightly at wrists and ankles, and lined throughout with fur. Through these suits, between the fur and the outer coverings, were placed wire cables terminating in snap-fasteners at neck, wrists, and ankles, to which could be attached silk-covered wires leading to other electrical heating units in the helmets, gloves, and moccasins, all of which were warmed by

a current drawn from the generator on the engine. Hence, though our aviators not infrequently flew in a temperature of thirty degrees below zero, they were as warm and comfortable as though they were sitting before a log fire at home—much more comfortable, in fact, than were their relatives and friends in America on the fireless Sundays which made uncomfortable the first winter of the war. On his hands the aviator wore, in addition to the electrically heated gloves, a pair of muskrat gauntlets extending nearly to the elbow; on his feet, over the electrically heated moccasins, another pair of moccasins, lined with sheepswool, reaching almost to the knees. It is scarcely necessary to add that our air-fighters spent more time in dressing than does a chorus-girl in a comic opera, and that when they were dressed they looked like a cross between an Arctic explorer and a deep-sea diver.

The question of obtaining the fur for lining this clothing presented a perplexing problem, for there were required vast quantities of pelts or skins of extreme warmth and sufficiently strong to withstand rough usage, but not too bulky or heavy. After considerable investigation it was found that these requirements were met by the skin of the Nuchwang dog, which inhabits one of the provinces of north China, though I have no doubt that sable or ermine would have answered the purpose equally well had cost been no consideration. The demands of the American Air Service required practically all of these skins that could be had in China and necessitated the lifting of an embargo to bring them into the United States,

which, thanks to the co-operation of the War Trade Board, was obtained. The last purchase before the Armistice was signed called for 500,000 of these dog-skins. A strange thing, was it not, that the lust for power of one William Hohenzollern, late of Berlin and Potsdam, should bring about, among countless other things, the slaughter of half a million dogs in far-off China? Though figures are, as a rule, dry things, the magnitude of the Air Service's clothing problem can be better appreciated by my giving a few of them. The work in hand for air-clothing when the Armistice was signed involved upward of $5,000,000. Fifty thousand fur-lined flying suits at $36.25; over a 100,000 leather helmets at $4.50; a like number of leather coats at prices ranging from $10 to $30, and 80,000 goggles at $3.50 a pair reflect the major items and explain how the government spent some of the money which you paid for your Liberty Bonds.

Though in this chapter I have attempted to sketch the manifold phases of America's preparation for obtaining supremacy in the sky, I have purposely left until the last the most important phase of all—the flying-men themselves. The personnel side of the Air Service, including the selection, training, organization, and operation of the flying forces, developed, within the year following America's declaration of war, into one of the most remarkable educational systems in this or any other country, with a larger student body and a more diverse curriculum than any university in the world. Teaching men to fly, to send messages by

wireless, to operate machine-guns in the air, to gauge the effectiveness of artillery-fire by its bursts, to read and make maps, to operate gas-engines, and to travel hundreds of miles by compass; teaching other men to read the enemy's strategy from aerial photographs, and still others to repair instruments, ignition systems, propellers, airplane wings, and motors, required a vast network of schools and flying-fields, a huge force of instructors, many of whom themselves had to be trained, and an amazing mass of equipment and curricula.

The pilot is the heart and brain of the whole flying apparatus. Parts of the airplane may break without serious result, but when the pilot breaks, even momentarily, nothing is left to direct the flight. The man and the machine come crashing to the ground. The early view that any one who "had the nerve" could fly caused hundreds of unnecessary deaths and an enormous avoidable waste of material. The lesson, for which we paid in bitter and costly experience, was that it is essential to choose flyers who are especially fitted for particular work, and then to keep them in condition to perform their duties at all times by using the same thought and care which is expended in the feeding, exercising, and conditioning of a race-horse. Nature, remember, never intended man to fly in the same sense that she did not intend him for life in a submarine. Conditions are unnatural from the time he leaves the ground until he returns. There are countless obstacles which he must overcome. He flies in an atmosphere deficient in that oxygen which is "the breath of life"; he is subjected in war to the

shell-fire of antiaircraft guns and attack by enemy aircraft; he travels through space at a speed far exceeding that of the fastest express-train. In attaining altitudes and breathing rarefied air, the flyer is shaking his fist in the face of nature.

It is imperative, therefore, to classify the flyer for the kind of work he is physically capable of performing. Some men are not able to fly at higher levels than a few thousand feet without suffering deleterious effects, while others may operate at five miles above the surface of the earth without physical harm. It is necessary to know a flyer's limitations before his training is specialized, for the saving of time and money, and, indeed, the flyer himself. Just as the trainer of a varsity track team classifies his available material into sprinters, distance men, broad jumpers, high jumpers, and weight throwers, so the director of a flying-school must classify his material into men fitted for combat, observation, and bombing. It would be an obvious waste of time and effort to train a man for combat work at high altitudes and then discover that his physical limitations permitted only of his doing bombing work at comparatively low levels. In order to accomplish this work of classification, branch research medical laboratories were established at the various flying-fields, which, by means of certain standardized tests, especially the one on the "rebreather" machine, placed the flyers in their proper categories. The rebreathing tests were conducted in a room so designed, by the gradual expulsion of its oxygen, as to create the exact and various conditions that would

exist at any known altitude. Physicians and physiological experts, themselves supplied with oxygen through tubes, remained in the room throughout the tests, closely observing the effect produced on the candidate by the gradual decrease of the oxygen supply. It was soon found that a man's faculty to respond to sight, sound, and touch becomes more dormant as the air becomes more rarefied, and it was to offset this condition that the oxygen apparatus which I have described in preceding pages was designed. The effect of low oxygen upon the mental process varies greatly, however, according to the individual. He usually becomes mentally inefficient at an altitude at which there is as yet no serious failure of his vital bodily functions. By simple tests of mental alertness during these rebreathing experiments, such as directing the candidate to press designated buttons controlling electric lights of certain colors, controlling a volume of sound by operating a pedal with his feet, and the like, it was easy to determine that one flier would lose his mental alertness at 15,000 feet, while another would retain full control of his faculties at nearly double that height.

In order to accomplish the best results, a comprehensive programme was undertaken, providing for the standardization of both tests and examiners. Sixty-seven military units were established, each examining from ten to sixty applicants a day, there being required, in addition to the complete physical examination embracing all the features ordinarily required of men entering the military service, rigid tests of the special

senses of vision, hearing, and motion sensing. Yet, despite the severity of the tests to which the candidates were subjected, the records show that 70.7 of the applicants qualified. But the work of the surgeons did not end when they had passed a man as physically fitted for training as an aviator. On the contrary, it had only begun. The candidate was not only kept under the closest medical observation during his training days, but this observation did not relax even after he had become a fully fledged flyer with the silver wings embroidered on his breast, for the "flight surgeon" who was attached to every squadron was instructed to keep the flyers physically fit and to carefully investigate the causes of all such accidents as might be attributed to the mental or physical failure of the flyers themselves. Keeping the flyer fit was by no means as simple a matter as it sounds, for it included seeing that the men took the necessary amount of physical exercise, the provision of proper recreation, watching the state of fatigue of the individual, making arrangements for leave or furlough, determining the quantity and nature of their food and the questions of alcohol and tobacco, and re-examining them at frequent intervals. Any one who knows how temperamental many flying-men are inclined to be will realize that the flight surgeons held no sinecures.

During the last few months of the war an apparatus was perfected whereby students could acquire flying experience and training without leaving the ground. This machine, known as the "Ruggles Orientator," is a modification of the universal joint, composed of three

concentric rings so pivoted as to permit the fuselage, which is pivoted within the innermost ring, to be put through every possible evolution experienced in actual flying—the candidate being able to experience, while safely on the ground, the sensations of nose-diving, tail-diving, side-slipping, looping the loop, and all the rest—everything, in fact, except forward progression. I feel certain that a man of Mr. Ruggles's amazing ingenuity could have satisfied both the parent and child of the ancient verse:

> "'Mother, may I go in to swim?'
> 'Yes, my darling daughter.
> Hang your hose on a hickory limb,
> And don't go near the water.'"

VII

"M. I."

IN writing the story of Military Intelligence I feel as though I were picking my way along a narrow and slippery path which is bordered on either side by precipices and is in places obscured by fog. On the one hand, I am in danger of unconsciously overemphasizing the mysterious and sensational aspects of the subject; on the other, of making it appear more commonplace and prosaic than it really is. And, at every few steps, I find my progress hindered by the veil of secrecy which necessarily enveloped certain activities of the division during the war, and which it has not been deemed wise entirely to lift with the return of peace. And there is still another difficulty. The public has in a large measure obtained its conceptions of military intelligence work from the novels of Sir Arthur Conan Doyle, Mr. Robert W. Chambers, and Mr. E. Phillips Oppenheim. So, if the pages of this narrative are not filled with alluring adventuresses of dazzling beauty, cloaked assassins, secret agents flitting about the countryside in high-powered cars, German barons disguised as head waiters, mysterious signals flashed by night to lurking U-boats, messages written in invisible ink, and midnight meetings in subterranean chambers, my readers will be disappointed and dissatisfied and will probably believe in their hearts that I am holding something out on them.

The story depends, after all, on the angle from which you look at it. I know an officer of the Military Intelligence Division who goes about on tiptoe, figuratively speaking, with his finger always on his lips. He is so tight-mouthed that Colonel House seems garrulous beside him. This officer has been of enormous service to his country, and the importance of his work fully justifies the secrecy and mystery with which he surrounds it, yet his duties have been performed at an office desk in Washington, with a table of logarithms at his elbow, and, so far as action and adventure are concerned, his life has been about as exciting as that of a professor of mathematics. I know another man, likewise connected with the Military Intelligence Division, who, assuming the guise of a workman, succeeded in obtaining admission to the councils of the I. W. W. and of criminals operating in the forests of the Northwest, and who did more than any single person, perhaps, to unearth the conspiracy which had for its object the crippling of our airplane programme. For weeks on end he carried his life in his hands, for, had his identity been suspected, he would have met a sudden and mysterious end by knife or bullet. Yet he speaks of his adventures as casually as though he had been in no greater danger than a Fifth Avenue policeman.

The fact is that the truth lies somewhere between the extremes represented by these two instances. The opportunities which have been afforded me to investigate the subject lead to the conclusion that, though Military Intelligence is, in many of its phases, as hard-

boiled and unromantic as Standard Oil, it is nevertheless thickly sprinkled with incidents and episodes which would have provided material for the creators of LeCoq and Sherlock Holmes. Though a fairly careful perusal of the files of "M. I. D.," as the Division of Military Intelligence is commonly referred to in the army, discloses no evidence that German spies of the caliber of Karl Lody and Bolo Pasha operated in this country during the war, they do contain the *dossiers* of enemy agents whose personalities and exploits meet all the requirements for characters in spy fiction. Probably the nearest approach to the high-class spy, as made familiar by the articles in the Sunday supplements and the magazines, was Captain Franz von Rintelen, naval attaché of the German Embassy in Washington, who is now enjoying an enforced sojourn in a large stone château as the guest of the government. Though the equally notorious Madame Victorica, a titled adventuress in the pay of the Wilhelmstrasse, filled several of the specifications of the secret agent of fiction, truth compels me to destroy certain illusions which the public has held concerning this lady by stating that she was by no means young, that she was only passably good-looking, and that she was so far from clever that her own boastfulness led to her apprehension. The other enemy agents who operated in this country were, for the most part, former privates in the German Army or petty officers and stewards on German liners, the most picturesque of the lot, a man named Bode, being so inefficient that he was dismissed by his own government, whereupon, being without funds, he surrendered

himself to the American authorities. He will receive board and lodging at government expense for some years to come. Though the beautiful young Madame Storch, who died under mysterious circumstances at Ellis Island a few days after her arrest, possessed a certain romantic interest, she and her three companions were so weak in character and of such small-caliber intelligence, that it is exceedingly doubtful if the Wilhelmstrasse ever intrusted them with any important work or confided to them any important secrets. Let it be perfectly clear, however, that nothing is further from my intention than to minimize the deadly gravity of the German-spy menace in this country during the war, or to suggest that, had no steps been taken to check it, it would not have caused the loss of millions of American dollars and thousands of American lives. That the national safety was not more gravely imperilled by these enemy agents was not due to their inefficiency, or to the weakness of the German espionage system, but to the efficiency, resourcefulness, and unremitting vigilance of the Division of Military Intelligence, which, I might add, frequently carried on its work under the most disheartening condition.

Military intelligence is the term applied to all such information as may be of value to the successful prosecution of a war. The Military Intelligence Division is that branch of the General Staff which is organized to secure this information. Its field of inquiry includes the investigation of active and potential enemies, allies, and neutrals; their military, political, and economic condition; their state of mind, their secret ac-

tivities at home and abroad, and their strategic and tactical plans for present or future campaigns. A well-organized intelligence service provides, moreover, for estimating and safeguarding the resources of its own country; for protecting war industries and means of transportation; for stimulating the morale of its troops and of the civil population; for frustrating enemy agents and preventing the dissemination of enemy propaganda. Thus arises the distinction between the positive and the negative aspects of the service. The former, known as Positive Intelligence, concerns itself with the collection and distribution of information. It publishes estimates of the military, economic, political, and psychological status of various countries; prints maps of enemy districts, with particular reference to fortifications, harbors, and routes of travel; deciphers intercepted messages, and translates foreign documents. The Negative Branch of the service concerns itself with the frustration of all agents, military or civil, who are consciously or unconsciously of value to the enemy. This is known as Counter-Espionage, or Negative Intelligence. It establishes a system of propaganda designed to neutralize the propaganda of the enemy; it detects and causes the arrest of spies among the troops as well as in the civil population; it censors news and information given to the public; it prevents enemy agents from entering or leaving the country, and it investigates the causes of economic disturbances and unrest.

Though military intelligence work was undertaken by the army in 1885, in response to a demand for in-

formation from the Secretary of War, it was not until the United States found itself an actual belligerent in the Great War that the immense importance of the work was fully realized. Incredible as it may seem, when General Pershing set sail for France in the spring of 1917, the entire personnel of the Military Intelligence Section, as it was then called, consisted of four officers (of which one was myself) and three clerks. Due, however, to the forcible arguments and the breadth of vision of its first chief, Colonel Ralph H. Van Deman, the foundation was laid for the present vast organization, whose activities expanded, at the demands of war, until, when the Armistice was signed, they virtually covered the globe. In addition to the huge military intelligence personnel in Washington, a carefully organized intelligence service is maintained in each camp, post, and station, as well as in the field. Though these officers are appointed by their respective division or department commanders, the responsibility for their instruction and the control of their counter-espionage activities rest upon the Director of Military Intelligence, at present (June, 1919) Brigadier-General Marlborough Churchill. During the war the Military Intelligence Division maintained the closest liaison with the Director of Naval Intelligence, the Department of Justice, the agents of the departments of State, Labor, and the Treasury, the War Trade Board, the War Industries Board, the Censorship Board, the National Research Council, the American Protective League, and the Council of National Defense, all of these organizations being able, through the medium of their countless

branches, agents, and correspondents, to provide Military Intelligence with enormous amounts of valuable information which it could not otherwise easily have secured.

The Administrative Branch of the Military Intelligence Division, referred to, for the sake of convenience, as M I 1, co-ordinates the activities of the other eleven sections, six of which, M I 2, M I 5, M I 6, M I 7, M I 8, and M I 9, form the Positive Branch of the service, the Negative Branch consisting of M I 3, M I 4, M I 10, M I 11, and M I 13. The Second Section (M I 2) is divided in turn into five subsections, four of which—Combat, Political, Economic, and Psychologic—devote themselves to the collation of information, the maintenance of the "Current Estimate," of which more hereafter, and the furnishing of special reports. Another subsection deals with the preparation of military monographs. M I 5 collects information for the use of the Positive Branch and supervises the military attachés. M I 6 concerns itself with the translation of documents for all branches of the War Department. M I 7 has charge of all maps and photographs, one of its subsections devoting itself to map construction and another having the custody of the War Department map collection. To M I 8 is intrusted the solution of codes and ciphers, the study of shorthand systems, encoding and decoding, the compilation of codes, and the maintenance of a laboratory for the detection of invisible inks. M I 9 has supervision of the training of intelligence officers and men for work in the field. Turning to the Negative Branch of the division, M I 3 is charged

with counter-espionage within the military establishment, together with collateral activities directly affecting the army. The eleven subsections of M I 3 deal with such diverse subjects as the preparation of bulletins, summaries, and surveys; and of instructions for intelligence officers, counter-espionage in prison camps, disciplinary barracks, the District of Columbia, the various branches of the Staff and Line, and among conscientious objectors, and the investigation of applicants for commissions. M I 4 conducts counter-espionage outside the military service in the United States and abroad, with particular reference to sabotage and the protection of plants and means of communication, its activities covering nearly the entire world. M I 10 is charged with the censorship of letters, books, newspapers, and periodicals, telegraphs and telephones, and radiophotographs and motion-pictures, and with a general supervision of the foreign-language press. M I 11 passes on passport applications and, in co-operation with certain other bureaus, has charge of port control. M I 13 is the Graft and Fraud Section, its work being principally concerned with criminal activities which may affect the army. The present Morale Branch of the General Staff consists, as its name indicates, in maintaining the morale of the army, which includes the encouragement and supervision of soldier publications, military advertising, camp-posters, and the treatment of the foreign-speaking and negro soldier problems originated as the Military Morale Section of Military Intelligence.

M I 2, as I have already explained, is that section

of the Military Intelligence Division whose duty is to collect, collate, and distribute *foreign* intelligence, its Combat Subsection being charged with the preparation, maintenance, and dissemination of combat and military information on all countries. The work of the subsection is classified as "active," "static," and "encyclopedic." The "active" work consisted, during the war, of the preparation of material for the *Daily Summary* and the *Weekly Summary*, and of material for transmission to other governmental departments; the preparation of *Front Summaries* and *Strength Summaries;* the transmission of a special weekly report to the American Expeditionary Forces in Siberia; the establishment and maintenance of line-maps of the various active fronts in the offices of the Chief of Staff, the Secretary of State, the War Council, the War College, and in the House of Representatives. In addition this subsection was charged with the preparation of a weekly résumé of the situation on all fronts to be presented to the heads of the several army bureaus, of the industrial bureaus, and the military committees of the Senate and the House. The "static" work consisted in keeping up to date the combat portion of the *Current Estimate of the Strategic Situation*, where was presented in concise form a wealth of combat, economic, ethnic, political, and psychologic information for ready reference by the Chief of Staff and other general officers who were compelled to keep their fingers constantly on the pulse of the enemy and Allied nations. The "encyclopedic" work consisted of the compilation of military and combat information of a permanent character.

During the war there were few more interesting places in Washington—and none, perhaps, more difficult to obtain access to—than the map-room of the Military Intelligence Division. On its walls were displayed every conceivable sort of map and diagrams depicting the movements of the armies on the various fronts. Not only were there large-scale maps of the European fronts on which our troops were fighting, but there were likewise maps on which rows of tiny colored flags indicated the positions of the opposing forces in Russia, Siberia, Macedonia, Mesopotamia, Palestine, China, German East Africa, German Southwest Africa, and the Cameroons. These maps recorded, not only from day to day, but frequently from hour to hour, the advance or retreat of the lines on the various fronts, besides representing in graphic form the location of the enemy forces and indicating any economic conditions which were of particular interest at the moment. Thanks to the completeness of our information and the speed with which it was transmitted from the battle-fronts to Washington, the Director of Military Intelligence could sit in his map-room and follow the progress of a great battle on the Western Front as readily as the crowd in front of a newspaper office can follow a battle on a baseball diamond by means of the automatic score-board.

In addition to the unceasing care and study necessary for keeping the maps of the various fronts up to the minute, and for anticipating events so that maps which might be needed in the near future would be ready, as, for example, when we first contemplated

sending an expedition to Italy or when we learned that the British were preparing to invade Palestine, the staff of the map-room had many other duties. It verified every name which occurred in the cables which were constantly being received from every corner of the globe (and if you have ever seen what a cable operator can do to geographical names you will appreciate how far from a sinecure this task was); it answered periodic letters from the Custodian of Alien Property requesting information as to the situation and possession of various enemy-owned estates, and it dealt with demands for every conceivable sort of information from every conceivable quarter. For example, the National Geographic Society asked for the boundaries of the Ukraine, which the society's geographic experts had been unable to determine themselves; the Naval Intelligence Division inquired about maps of northern France and where it could obtain them; the Shipping Board wanted information regarding French coastwise services. When the Siberian Expeditionary Force was being organized it became imperative that its commander should have an English map of the Trans-Siberian Railway. No such map had ever been made, but by a stupendous effort the officers of the subsection succeeded in translating three sections of the available Russian map. The other sections were translated by the War College, and the whole was reproduced by the Military Intelligence Printing-Office. The work was, of course, hastily done, and later had to be revised, but for the moment it served its purpose well, and the Expeditionary Force

was able to take with it the only complete map of that system in English in existence.

In addition to the great number of combat, strategic, and physical maps covering the belligerent countries and the various theatres of war, complete sets of military maps of the neutral nations were also kept available, for there was never any certainty as to how far the conflagration might extend. While hostilities were in progress the subsection responded to a constant stream of demands for estimates of the military situation, of the enemy's strength and resources, and for forecasts of his plans. An enormous amount of information relative to German and Austrian munitions, tanks, gas, aircraft, artillery, and infantry equipment was also codified and distributed in pamphlet form to those branches of the War Department particularly concerned. Statistical reports, showing, for example, the percentage of French and British officers wounded and killed during stated periods, were of great assistance to the War Department in determining the number of officers to be assigned to the various draft contingents and for figuring the replacements which would be required. A report showing the housing facilities for planes possessed by the French Air Service materially aided our own Department of Aeronautics. The rate of pay for prisoners of war was fixed by the Adjutant-General's Department with the aid of tables furnished by this subsection. Nor did the work of the subsection end with the signing of the Armistice. If anything, it increased, for it was called upon to furnish all sorts of highly technical informa-

tion for the use of the peace delegates. The most interesting and important data thus supplied was a translation, with copious notes, of a Russian document describing in great detail the growth of the movement for the political independence of Siberia, a complete plan for the organization of voting districts, the composition of scores of territorial councils and commissions, and the effect on political life in Siberia of the revolutions in European Russia.

Long before the entry of the United States into the war it was recognized that the struggle for the control of raw materials was fully as important a factor in the great conflict as the struggle of the armies themselves, and that the food supply exercised a greater effect on the morale of a nation than its casualties on the battle-field. Other factors which, it was realized, had to be taken into consideration in estimating the fighting ability and staying powers of a nation were labor conditions, finance, shipping and ship-building, all of which bear an intimate relation to the production of munitions and essential supplies. There existed government agencies, such as the Department of Commerce and Labor and the Department of Agriculture, as well as many others born of the emergency, that were organized for the purpose of collecting data on all these subjects, but the results of their activities were not readily available for the purpose of the General Staff. As a consequence the need arose for a section of the Military Intelligence Division to gather, collate, and co-ordinate such economic information, and, in particular, to interpret it from the military standpoint. The

Economic Subsection of the Positive Branch was created, therefore, to supply this need.

The chief, and indeed the most important, function of the subsection was the compilation and the constant revision—based on the latest and most accurate data obtainable—of the economic portion of the *Current Estimate of the Strategic Situation.* Dealing as it did with vital economic conditions in all the countries of the world, it enabled the high command of the A. E. F. and the other organizations, both military and civil, to whom it was distributed, to keep in constant and intimate touch with the economic situation throughout the world. This work constituted, in fact, an up-to-the-minute encyclopedia of the most vital economic factors as they related to the strategic situation. The I. W. W. troubles in the spruce forests of the Northwest, the spread of boll-weevil in the cotton-growing districts of the South and of hoof-and-mouth disease on the Texas cattle-ranges, riots in Korea, revolutions in Russia, the assassination of a dictator in a Central American republic, a shortage of the Brazilian coffee crop, a change of government in Chile, a textile strike in Lowell, Mass., the price of bread in Bavaria, the increased use of paper clothing and leather substitutes in Prussia, the speech of a Socialist deputy in Paris, all were carefully weighed and given due consideration, the conclusions thus arrived at, when condensed and put into graphic form, enabling the military chiefs in Washington to gauge with amazing accuracy the economic conditions throughout the world and to forecast the effect which they might be expected to have on the fighting armies.

Commencing early in 1918, the subsection contributed to the confidential *Weekly Intelligence Summary* specially written articles dealing with particular phases of the economic situation in various countries, such as "*Germany's Raw Materials,*" "*The Food Supplies of Germany,*" "*Turkish Finances,*" and the like. These articles, which were frequently accompanied by specially prepared maps, tables, and diagrams, were all of a confidential nature, and were of great importance to a complete understanding of the strategic situation and its constantly shifting phases. The signing of the Armistice naturally brought about a sudden change in the nature of the subsection's work, its articles becoming more monographic in character and dealing with conditions from all points of view but with particular reference to the future. Such articles included "*The Coal Situation in Germany,*" which was a detailed account of Germany's use of the coal-fields which she occupied during the war; "*The Left Bank of the Rhine,*" being a comprehensive study of this territory from the view-point of the effect which its neutralization would have on the future of Europe; "*Economic Resources of Czecho-Slovakia,*" with a valuable map of railroads and mineral deposits in that newly born nation; "*Palestine,*" with an account of the resources, railroads, and prospects of the "State of Zion"; "*Baltic Ports,*" a monograph which showed the necessity of developing these ports and their hinterlands for the development of Russia. Upon the despatch of the American expedition to Siberia, the Economic Subsection produced a weekly economic report on Russia,

with particular reference to the Asiatic territories, which was regularly forwarded to the commander of the expedition at Vladivostok. There were also prepared for the use of our forces in Siberia monographs on the food and raw-material resources, the communications, the industries, and the finances of Russia, these proving of enormous value to the staff of the expedition, which was operating in a region of which next to nothing was known save by a handful of scientists and explorers. Among the countless other reports prepared by the subsection perhaps the most important was the one on the fortifications and the territory surrounding the great German stronghold of Metz, which, had the war continued, would have been attacked by our forces. The completeness and exactitude of the information contained in this report, which was verified by persons familiar with the fortress and its environs, would, I imagine, have given the chiefs of the German Intelligence Bureau some very uncomfortable nights, had they known of its existence.

Now, though the non-military person may not have realized it, an exceedingly important factor in the successful conduct of operations is an adequate supply of up-to-date geographical monographs and handbooks, describing in completest detail the regions where the operations are taking place. Imagine, for example, how much difficulty you would experience and how little information you would obtain if you were to visit the galleries of the Vatican, the museums of Florence, or the churches of Venice without a guide-book. As few of the statues and pictures are labelled, you could

only hazard a guess as to what you were seeing; you would not know where to go next or how to get there. The same thing holds almost equally true of armies. Land an expeditionary force in Patagonia, let us say, and imagine how helpless it would be if it had no accurate and detailed information as to the topography of the country, the size and locations of the towns and villages, the nature of the crops, and the customs of the natives. To fill this urgent need there was created the Military Monograph Subsection. The gradual evolution in the methods of this subsection may be summed up by saying that stiff official letters, the very tone of which was about as reassuring to the recipient as a court summons, have given place to informal, friendly communications which immediately create a bond of personal sympathy between the Intelligence Division and the person from whom information is desired; the questionnaires sent out by the subsection to those believed to have special knowledge of certain regions have dwindled from ponderous and forbidding volumes, the mere labor involved in answering which was appalling, to single pages of easily comprehended questions; and sets of stereotyped queries have, wherever possible, been replaced by intimate personal interviews. In other words, letters which addressed the recipient as "Sir" were so humanized that, when the war ended, they frequently began "Dear Bill."

The most important work of the Military Monograph Subsection was the preparation of military handbooks which described, with almost incredible wealth

of detail, the regions in which our forces were operating or in which they might operate at some future time, the volumes being by no means confined to Europe and Asiatic Russia. The method followed in the preparation of these small, pocket-sized, linen-covered volumes was as follows: From standard sources, such as Baedeker's and Murray's guides, the best possible description of a given region or route is compiled, or, should guide-books on the region in question be unobtainable, an account is obtained from some experienced and reliable traveller. This skeleton is then enlarged, improved, and brought up to date by the careful perusal of consular and other reports and of all sorts of confidential documents issued by our own and other governments, and by reference to reliable books of travel. An even more fruitful method of obtaining new and valuable information is through interviews with travellers, explorers, mining engineers, consuls, commercial travellers, sea-captains, and others who have had opportunities to familiarize themselves with the regions about which information is desired. If these men were asked to sit down and dictate accounts of their observations, the results would probably, in nine cases out of ten, prove highly unsatisfactory, but if a written account of the region under discussion is given them, it invariably acts as a great stimulus to their memories. Though a man may not be able to write as good an account from first-hand knowledge as the intelligence officer has prepared from material obtained in a library, he is easily able to point out errors, to suggest additions, and in other ways to

improve the version placed before him. The last and potentially the most valuable of the methods used in gathering information for these handbooks is the employment of the Military Intelligence Division's own agents, such as military attachés, diplomatic and consular officers, and other civilian agents who are sent to foreign countries with specific instructions as to the information which it is desired to obtain. I might add that this has shown itself to be the most satisfactory source of information for monographs and handbooks. It is no exaggeration to say that each of these handbooks—and already a score or more of them have been completed—represents the combined knowledge of from forty to a hundred people.

The Siberian handbooks published by M. I. undoubtedly present the fullest and most accurate date on routes of transportation in that country to be found anywhere save only in the archives of the Russian, Japanese, and German armies. The handbook entitled *Southwestern Russia* contains minute descriptions of all the ports on the Black Sea from Varna, in Bulgaria, around to Batoum, in the Caucasus. It also contains such information as would be required by an expedition in regard to the selection of ports for the disembarkation of troops and supplies, the garrisoning of these ports, and their maintenance as bases for operations in the interior. In August, 1918, when the American Expeditionary Force was about to set sail for Vladivostok, the Military Monograph Subsection was suddenly called upon to furnish the staff of the expedition with a handbook on eastern Siberia. Though

much of the necessary material was contained in documents which had not yet been translated, and though there were available only a few persons who were intimately acquainted with the region in question, the subsection, by placing its entire personnel at the task and by working eighteen hours a day, succeeded in producing a preliminary but really admirable little handbook which was mimeographed in time to go with the expedition. It is scarcely necessary to add that the preparation of these monographs demanded men of exceptional ability who possessed wide and intimate knowledge of the regions whereof they wrote. In order to provide such a corps of writers, commissions in the Military Intelligence Division were given to travellers, explorers, authors, scientists, archæologists, and others whose work or pleasure had acquainted them with the world's far places.

The Propaganda Subsection of Military Intelligence was formed for the purpose of studying enemy propaganda, to combat it by means of suitable counter-propaganda, and to take steps for the dissemination in the enemy armies and enemy countries of positive propaganda of our own. Though propaganda, as used by the United States, was nothing but the truth, it had been so abused by the Central Powers as to have become almost a term of reproach, the American Government steadily opposing its use—at least under that name—during the earlier months of the war. German propaganda had, indeed, achieved such an unenviable name that it was found advisable, in the spring of 1918, to change the name of this branch to "Psychologic

Subsection." Misleading and frequently flagrantly untruthful though their propaganda was, the Central Powers had made use of it with such marked success, particularly in Italy—for the disaster at Caporetto was primarily due to Austrian propaganda introduced into the Italian lines—that our government was reluctantly compelled to recognize its efficacy and to initiate propaganda of its own, this delicate and highly psychological work being intrusted to a civilian organization—the Committee on Public Information. Despite the vast amount of publicity which has been given to the work of Mr. Creel's organization, truth compels me to assert that it was very far from being the success which the public has been led to believe. Memorandums concerning the foreign situation, together with comments and suggestions, were sent almost daily by Military Intelligence to the committee, thus giving the civilian organization the military point of view and bringing to its attention urgent calls for American propaganda made by its representatives in many parts of the world. This should have been of great value to the committee, since through its attachés, agents, and other sources, Military Intelligence was able to obtain a vast amount of information about enemy propaganda and morale which would not otherwise have been accessible to Mr. Creel's organization. Although the committee agreed in general with the Intelligence Division as to the scope of our propaganda, lack of funds and of experienced personnel made it unable to act, in the majority of cases, on the information thus given. Incredible as it may seem, in view of the immense im-

portance attached to the use of propaganda by other nations, it was not until after the Armistice had been signed that the army was formally authorized to make use of this potent weapon. I mention this because it illustrates how difficult it is to obtain a satisfactory liaison between two such bodies as the Military Intelligence Division and the Committee on Public Information, whose respective activities were based on entirely dissimilar foundations, and who carried on their work along entirely different lines. This is not saying, however, that the officers of the Psychologic Subsection attached to the expeditionary forces in France were idle all this time; on the contrary, they succeeded in getting three million leaflets over the lines.

Early in the spring of 1918 Military Intelligence recommended the immediate purchase of 6,500 balloons to be used for distributing great quantities of propaganda leaflets behind the German front. As, however, a sufficiently large appropriation could not be obtained, and as it was feared that there would not be an adequate supply of gas for the purpose in the A. E. F., it was finally decided to order only 500 balloons. Though delivery was promised by November 1, they did not arrive then, nor were they received before the Armistice was signed, such few balloons as were used by the Propaganda Section of the A. E. F. being British ones. These were paper affairs, about nine feet long and carrying four pounds of leaflets strung on a slow-burning 12-inch fuse in such a manner that they were dropped in small bunches, thus securing a wide area

of distribution. But bad weather, the shortage of hydrogen-gas, the difficulties in transporting the gas-cylinders, and the rapid changes in the battle-line combined to make the number of balloons actually despatched very small. Great expectations were based, however, on the balloon campaign which was planned for the winter of 1918–1919 against interior Germany, particularly the Rhine towns. A large number of leaflets were also distributed by American aviators, who, taking their lives in their hands, frequently flew so low that they could see the Germans picking up the literature which came fluttering down on them from the skies.

In order to intelligently distribute propaganda by balloon, it was first of all necessary to ascertain the actual state of the enemy's morale, which was principally done by questioning prisoners. The officers in charge of the work—all of whom possessed, of course, a fluent knowledge of German—after carefully studying the daily intelligence reports at General Headquarters, would visit the war-cages near Toul and Souilly and hold long interviews with prisoners of all ranks and from all parts of the empire. By this means it was possible to gauge with a considerable degree of accuracy the existing conditions beyond the Rhine and the degree of importance which various sections of the German people attached to America's entry into the war. Arguments which had been suggested as suitable for propaganda use were tried out on the prisoners and their effect noted. Specimens of Allied propaganda were discussed with them and they

were asked to give their opinions of it. A sufficient knowledge was thus gained of the Teutons' mental processes to give the officers of the Propaganda Section a fairly accurate idea of the sort of arguments which would make the strongest appeal. The text of the proposed literature was then prepared and, after being approved by General Headquarters, was printed in Paris, the leaflets being sent to the field-stations which the Propaganda Section had established at Bar-le-Duc and Toul. As a result of the close liaison maintained with the Air Service, leaflets were sent to the various flying-fields for distribution by airplane, careful records being kept of the areas thus covered.

Almost from the start the liveliest interest was shown and the heartiest co-operation afforded by all branches of the army concerned. The Meteorological Section of the Signal Corps carried on an elaborate series of experiments to determine the rate of ascension of the various types of balloons. The G-2's of many corps and divisions constantly sent in requests for propaganda and offered many suggestions. And the aviators, who were, after all, the ones most directly concerned, showed not the slightest hesitation in undertaking the exceedingly dangerous work of distribution, for more than one German commander announced that he would execute any flyer captured in the act of distributing propagandist literature. In only one quarter was opposition encountered. That was where the out-of-date conviction was still held that "propaganda has no place during operations."

Nearly a score of types of leaflets were distributed

by airplane or balloon. Among the most successful was one known as the "Prisoner Leaflet," containing a translation of an extract from the orders prescribing the treatment to be accorded by the A. E. F. to prisoners of war. Appended to it was a list of rations issued to the American soldier and prescribed for enemy prisoners. More than a million copies of this leaflet were sent over the enemy lines. The "Prisoner Post-Card" leaflet was a variation of the one just described, being printed in close imitation of the German *Feldpostkarte*. This was predicated on the idea that the first interest of the German soldier was solicitude for his family and that the *Feldpostkarte* form was one to which he was accustomed. A number of these were found on the persons of prisoners. Another leaflet had a picture of a file of soldiers rapidly increasing in size, thereby impressing even the most illiterate of the enemy with the amazing expansion of the American Army. Still another contained the German request for an armistice and President Wilson's reply. The principal reason for dropping these over the German troops was the belief, which proved to be well founded, that their full import, and indeed even their complete texts, had been kept from reaching the German soldier. In addition to the above, the Propaganda Section distributed some 20,000 copies of a leaflet designed to appeal to those natives of Alsace-Lorraine serving in the German armies.

The leaflets intended for the Alsace-Lorrainers were the work of Captain Osamm of the 4th Corps, and were part of a plan which was to culminate in a

venturesome attempt at fraternization. Captain Osamm was perfectly familiar with German Army organization and knew the names of hundreds of German officers and men in the 224th Division, which was largely recruited from the natives of Alsace-Lorraine. After the 224th had been all but snowed under by the leaflets, and after a sufficient time had elapsed for the arguments which they contained to penetrate the German mind, Captain Osamm planned to crawl out into No Man's Land, and when within speaking distance of the German patrols to call out the names of individuals in that division. He admitted that he expected to be met by a few bursts of machine-gun fire, but he was convinced that the patrols would eventually themselves come forward to meet him, whereupon, by a verbal reinforcement of the arguments contained in the leaflets, he expected to bring about wholesale desertions. He based his assumption that the enemy would respond to his summons, I imagine, on the British contention that all Germans had originally been waiters, and that, if one were to shout, "Hi, Fritz, bring me a beer!" they would respond from force of habit. The beginning of active operations abruptly halted this amazing performance, however, thereby deeply disappointing the adventurous captain.

The speed with which events moved during the last few weeks of the war prevented the trial of a distinctively American idea, known as *The International Bulletin*. This was to be issued in the form of a newspaper, printed in parallel columns of English and Ger-

man, and distributed on both sides of the line. The intention was for the American forces to honestly share a newspaper with the Germans! It was believed that the very frankness of such a proceeding would serve to diminish the suspicions of the enemy that all leaflets which fell into their hands were "doctored." The bulletin, as planned, was to contain news items, chiefly concerning the A. E. F., maps, pictures, and cartoons, the intention being to distribute it in large numbers among our own troops as well as behind the enemy lines; then to collect the old copies from the Americans, together with any comments which the fun-loving Yanks may have written on the margins, and send them over to the Boche by balloon.

What were the results of this propaganda offensive? Making an estimate of how it affected the enemy is like reporting on the effects of artillery-fire or bombing raids, for they happened on the other side of the line, "where visibility was poor." Any one who has listened to the interrogation of German prisoners can hardly fail to have been struck by the wide variance in the replies given by soldiers from the same unit. Questioned about the effect of a barrage, for example, one man would state that it destroyed the German wire, demolished their trenches, and cut their communications, and that he and his companions were demoralized and panic-stricken; while another prisoner, from the same company, perhaps, would defiantly insist that the Yankee shell did no great damage, that casualties were light, and that he never missed a meal or a night's sleep. Or, when interrogated in regard to the damage

caused by our bombing squadrons, one prisoner would insist that, beyond killing a cow and breaking a few windows, absolutely no harm was done, while another, visibly shaken by his experiences, would assert that all that remained of the town in which he was billeted was a hydrant and two paving-stones. German officers, when questioned about the effect of our propaganda, invariably made the stock reply, "The men laughed at the leaflets," but the enemy privates generally admitted that they read and believed the *flug blätter*. On the other hand, captured officers frequently complained about the depressing effect which the leaflets had on the morale of their men, while many privates stoutly denied having been influenced by propaganda, even when the much-thumbed leaflets were found on their persons. It must be remembered, however, that no soldier likes to attribute his defeat to pieces of paper; he prefers to blame it on lack of food, the enemy's overwhelming superiority of numbers, and to his preponderance of artillery and machine-guns. If a historian ever has an opportunity to delve into the files of the German Intelligence Bureau, however, I imagine that he will find ample evidence that the showers of leaflets falling from the blue played no inconsiderable part in the collapse of the German war-machine. But, whatever the results of our efforts in this direction, as revealed by the light of history, the American people can be assured that never was a campaign of propaganda waged with such scrupulous regard for the truth. Though certain of our allies sent out material for distribution over the enemy lines which took considerable

liberties with the truth, to put it mildly, and though the French quite frankly made use of Bolshevistic arguments, appeals, and promises, the distribution of our own propaganda leaflets was delayed time after time in order that the General Staff might sift and weigh the statements which it contained until they contained nothing save sincerity and truth.

In the weeks that followed Foch's great offensive in the summer of 1918, it became increasingly apparent to those who were in a position to judge, that German morale, both in the heart of the empire as well as at the front, was imperceptibly but none the less steadily deteriorating. No one realized the significance of this to the Allied cause better than the chief of the Psychologic Subsection, who determined to watch the progress of the movement, just as a physician watches the progress of a disease, and to indicate its trend by means of a chart, like those on which nurses record the variations in the pulse and temperature of their patients. In pursuance of this plan, which was put into execution about the 1st of September, 1918, a daily report was prepared which contained in brief form all news in any way relating to German morale which had come in from all sources during the preceding twenty-four hours. At the end of each week an interpretation of the drift of these news items was attempted in a weekly report. Using as a basis for its estimates material contained in these reports, supplemented by information obtained from every source open to Military Intelligence, the subsection worked out its famous "Chart of German Civilian Morale,"

which, during the closing months of the war, occupied a conspicuous place on a wall of Secretary Baker's office. The chart was drawn on a sheet divided into cross-sections, each of which represented a day, while the heavy black line, writhing across the paper like a dying serpent, showed the wavering morale of Germany's civil population. Secondary lines depicted in graphic form the German military situation, the degree of political unity in Germany, the situation in Austria-Hungary, the state of the food supply in the Central Empires, and the U-boat sinkings. But it was, of course, the line indicating the state of civilian morale which most accurately gauged the situation. Starting in August, 1914 (nearly three years before our entry into the war), at the top of the chart, the line runs almost straight until the battle of the Marne, when there is a sudden drop. It recovers, however, with the continuance of the German advance, declines during the winters of 1914–1915 and 1915–1916, only to ascend again with the coming of spring; falls sharply after the final reverse at Verdun, drops to a still lower level than before during the anxious winter of 1917–1918, rises almost to its highest peak during Hindenburg's tremendous onset in the following spring; begins a gradual decline in ratio to the steady increase in the strength of the American armies, and finally, beginning with the defeat of the all-conquering Germans at Château-Thierry, goes plunging downward until, on November 11, 1918, the line ends at the bottom of the chart in the abyss of national despair.

Shortly after the Armistice, when the morale of

Germany's civil population was no longer of any interest save to the Germans themselves, the symptoms of a new and even more alarming disorder became apparent to the specialists of the Psychologic Subsection, whereupon, in order to keep this new menace to the health of the world under observation, a new chart was started and a fresh series of reports were begun, the personnel of the section being instructed to immediately note all movements and manifestations likely to prove destructive of good order and stable government. On huge wall-maps of Europe and Asiatic Russia various kinds of disturbances or threatened disturbances—revolutions, mutinies, riots, racial and religious troubles, strikes, labor and political demonstrations—were indicated by pins of different colors:

Red: Bolshevism, Syndicalist, or Socialist.

Brown: Political revolution, counter-revolution, anti-Bolshevist or social disturbances.

Blue: Industrial strikes.

Green: Food riots, plundering, or difficult food situation.

White: Racial troubles.

Black: Military mutiny.

Yellow: Disease epidemic.

Each day a report was made out, compiled from various sources, covering the subject of European disturbances, these reports being arranged geographically. Every Friday a weekly summary was prepared in numbered paragraphs, condensing the daily reports and giving, if possible, an interpretation of the trend of unrest during the preceding week. As the most threaten-

ing disturbances during the winter of 1918–1919 were of a Bolshevist nature, it was deemed advisable to issue a weekly report on the activities of Trotzky, Lenine & Co. and their followers.

The Fifth Section of the Military Intelligence Division, known as M I 5, is charged with the duty of obtaining positive intelligence, that is, of locating direct and indirect sources of information; of supervising military attachés, who, within the limits of their activities, obtain essential information, and of forwarding this information to such sections of the Intelligence Division as may find it of value. Now I am perfectly aware that the army officers who are attached to the American embassies and legations in various foreign countries do not stand particularly high in the estimation of the American people. They are generally regarded as men who have been selected for their wealth and social distinction rather than for their abilities as soldiers; who have had more experience in ballrooms than in bombarded cities, and are more successful in leading cotillions than at leading troops in battle. As a matter of fact, this estimate of our military attachés is bitterly unjust. As showing the type of men who represented the army abroad, I might mention that our military attaché in England during the early years of the Great War was Major-General George S. Squier (then a colonel), chief signal officer of the army and one of the foremost scientists in America, if not, indeed, in the world; our attaché at Paris was Colonel Spencer S. Crosby, one of the most able engineer officers in the army; while at Berlin our military rep-

resentative was Major-General (then Colonel) Joseph A. Kuhn, who, after organizing, training, and commanding in action the 79th Division, eventually rose to the command of an army corps.

Everything considered, the American military attachés have done more valuable work and received less recognition for it than almost any class of officers that I know. They have been placed in the unenviable position of taking orders from two departments—War and State; they have been forced, by the very nature of their duties, to play the rôle of onlookers while their fellow officers were fighting, and they have repeatedly been accused of being spies. Though the duties of our attachés in the capitals of our allies have been largely ornamental during the war, owing to the fact that they were virtually superseded in their military functions by the various American military missions, their work in the neutral countries of Holland, Denmark, Norway, Sweden, Spain, and Switzerland was of enormous importance, for they provided Military Intelligence with its most reliable and important source of information. Those officers stationed at The Hague, Copenhagen, and Berne could look across the barbed wire, figuratively speaking, and see for themselves what the enemy was doing. Through all sorts of agents—spies, smugglers, deserters, refugees, business men whose affairs took them into the territory of the Central Powers, and returning travellers—they were able to keep their fingers constantly on the military and economic pulse of the enemy, and to report the information thus obtained to the A. E. F. and to Washington. It goes

without saying that this work called for the exercise of the highest degree of patience, resourcefulness, and tact, for they were always surrounded by German agents, and particularly in those countries where German sympathizers predominated, the slightest indiscretion would have resulted in a demand for their recall. No news that came out of Germany was too trivial to escape their attention. Every one who crossed the frontier, from Dutch and Danish bankers to German deserters, was adroitly questioned and cross-questioned by the attachés, certain of the information thus obtained exercising a profound effect on America's military policy. For example, our attaché at The Hague was dining one evening with a Dutch banker who had just returned from a business trip to Germany. While chatting over the coffee and cigars the Hollander remarked that, though he had been the guest of a German nobleman of great wealth, he had not been quite as comfortable as on previous visits, owing to the absence of his host's butler.

"What has become of old Franz?" the Hollander had asked his host. "The place isn't the same without him."

"He was callea to the colors last week," was the answer.

"But surely he is too old for active service," the banker protested. "He must be nearer sixty than fifty; he is blind in one eye and he is crippled with rheumatism."

"Ach, yes," admitted the German. "But what would you? The Fatherland has need of every man."

This incident, related quite casually over a dinner-table, though trivial in itself, gave our military attaché — and through him our Military Intelligence — an intimation of the enormous depletion of Germany's man-power. Taken in conjunction with similar reports from other sources, it convinced him that Germany was fast becoming desperately hard up for men.

The attaché in Switzerland, perusing, as was his custom, the current issues of the German newspapers, had his attention attracted by an advertisement, inserted by a citizen of a south German city, offering to rent a pair of stout leather boots, in good condition, for six weeks for forty marks. When the equivalent of ten dollars is demanded for the use of a pair of boots for six weeks, there is only one conclusion to be drawn. "Germany must be at the last gasp for leather," argued the attaché, and he so informed Washington. His surmise proved perfectly correct.

Our military representative at The Hague was materially aided in his quest for information by a former sergeant in the American Army, who, upon his discharge, had bought a small truck-farm in southern Holland, within a few rods of the frontier. His dwelling was a recognized rendezvous for smugglers and deserters, the old soldier sending reports of the immensely important information which he obtained from them to the attaché at the capital as regularly as, when stationed at an army post in the Indian country, he turned in his company reports.

All cable messages sent by the military attachés to the Military Intelligence Division habitually ended

with the sentence "Pershing informed," which signified that the information had also been communicated to the Commander-in-Chief of the American Expeditionary Forces. Shortly after the arrival of the former Kaiser at Amerongen, the newspapers carried circumstantial accounts of serious political unrest in Holland. In order to correct the impression thus created, the attaché at The Hague, who was evidently blessed with a sense of humor, sent the following message to Washington:

> "*Everything quiet in Holland. The Kaiser is still with us. Pershing informed. God also.*"

Outside of Tiflis, in the Caucasus, in whose bazaars eighty languages are commonly spoken, I suppose that the Sixth Section of Military Intelligence, familiarly referred to as M I 6, is the nearest modern equivalent to the Tower of Babel. This section is charged with translating into English books, periodicals, newspapers, pamphlets, posters, proclamations, army orders, war diaries, confidential reports, Heaven only knows what besides, which appear in pretty much every language under the sun. The translators at present employed in the section make translations from the French, Italian, Spanish, Portuguese, German, Dutch, Dano-Norwegian, Russian, Swedish, Greek, and Icelandic. This comprises only a portion of the section's work, however, for it also makes translations from Roumanian, Ukrainian, Czecho-Slovak, Serbo-Croatian, Slovenian, Albanian, Bulgarian, Polish, Lithuanian,

Lettish, Finnish, Ladino (there's a strange one!), Hebrew, Yiddish, Turkish, Armenian, Assyrian, Syriac, Arabic, Hindustani, Bengali, Chinese, Japanese, Choctaw, and other North American Indian dialects, Samoan, a dialect of the Philippine Islands, and Esperanto. By an ingenious system of filing and indexing the information thus obtained, the section has become a sort of clearing-house for data gleaned from the foreign press.

M I 8 is the Cable and Telegraph Section of Military Intelligence. A portion of its work consists in sending and receiving telegrams and cables between the division and its intelligence officers on duty outside of Washington, including the military attachés in foreign countries. By means of special wire connections, remarkably fast service has been provided, particularly with the most important centre, Paris, whence messages in plain text have been delivered in Washington four hours earlier by the clock than they were despatched, while code messages have been delivered at approximately the same time by the clock that they were sent. As an illustration of the peculiar tricks played by the change in time, I might mention—though it has nothing on earth to do with the subject of Military Intelligence—that the news of the death of Queen Victoria was received in New York three and a half hours before the time at which she breathed her last!

By far the greater portion of the enormous amount of cable correspondence handled by this office has been in the form of code messages. Since the necessity for security has required that the code words of each mes-

sage be enciphered to prevent the possibility of the message being intercepted and read by the enemy, it has been necessary to subject each code message to two complete translations. It has also been the duty of this section, in order to insure secrecy and to secure economy in the transmission of messages, to prepare five code-books for publication. Few persons realize, I imagine, that the use of code by the Military Intelligence Division, the Adjutant-General's Office, and other branches of the War Department, as well as by the American Expeditionary Forces, has resulted in a saving to the government of at least 50 per cent in the cost of telegraphic and cable communications. The use of the Geographical Code has brought about an even greater economy by eliminating the necessity of spelling out foreign place names. Though hundreds of plays, novels, and magazine stories have been based on the work of code and cipher experts in this and other countries, the writers have usually painted in too vivid colors the romantic side of the calling. Though code and cipher work is frequently productive of exciting and dramatic moments, it is usually the intellectual excitement of a chemist who, after weeks of laborious experiments, discovers a new reaction, rather than the physical thrill which a detective experiences when he discovers a clew to a crime.

Because of the enormous number of foreign-born citizens who were brought into the army by the draft, or who entered it through the National Guard or as volunteers, the work of counter-espionage within the

military establishment itself was of vital importance, for a single traitor in the expeditionary forces might well have turned victory into disaster. Had it not been for the vigilance and efficiency of the Third Section of Military Intelligence, which was charged with counter-espionage within the military establishment itself, our hastily recruited and somewhat loosely organized armies would have afforded countless opportunities for the operations of enemy agents. I can give no higher praise to the work of this section than to say that, though numerous enemy agents succeeded in gaining admission to the military service in the United States, they did not succeed in getting overseas, where they might have done irreparable harm. So active were our intelligence officers, so carefully did they investigate the record of every man destined for service in France, that, of the two and a half million men in the A. E. F., not a single one, so far as I am aware, was convicted of espionage.

Every military organization operating independently, from a division down to a quartermaster depot, possessed its own counter-espionage organization, built up within itself for its own protection but operating according to a general plan and reporting directly to the Military Intelligence Division in Washington. During the war there were over 400 intelligence officers reporting to Military Intelligence, either directly or through department intelligence officers. In addition to these, there were special intelligence officers at certain highly important points: New York, Hoboken, Philadelphia, Pittsburg, St. Louis, New Orleans, Seat-

tle, and San Juan, Porto Rico—and twenty-one district intelligence officers stationed in centres of somewhat less importance. The privilege of direct communication, granted by the Secretary of War, enabled the counter-espionage organization throughout the United States to be controlled and co-ordinated without interference by the normal military command, thereby insuring additional secrecy for its operations and eliminating the enormous amount of time and red tape involved in sending communications through the usual military channels. Each intelligence officer corresponded directly and freely with every other intelligence officer, copies of such lateral communications being sent to Military Intelligence, the files of M. I. thus becoming a great central reservoir for intelligence information of every sort. As a result of this organization, the Director of Military Intelligence, sitting at his desk in Washington, was the centre of a vast network of intelligence officers and other agents which covered not only the whole of the United States but, indeed, the greater part of the world.

The ever-present problem presented by counter-espionage work within the army was the determination of the loyalty of officers and men. Experience proved that the pro-German was almost certain to reveal himself sooner or later, or to be reported by some one who had known him, the loyal rank and file themselves constituting the most effective counter-espionage service of all. Investigations of men thus reported frequently showed, however, that, though the suspect might have been pro-German before our entrance into

the war, he had been apparently loyal since. If he was an enlisted man it was usually deemed safe to put him with line troops and send him to the front, for, even were he to prove disloyal, his opportunities for acquiring important information were comparatively few, and his opportunities for transmitting such information to the enemy almost infinitesimal. In the case of an officer, however, the question took on a far graver aspect, and only after the most searching investigation was such a man permitted to go overseas.

The activities of the men under investigation assumed many forms. First in importance, of course, though not in numbers, were those enemy agents who had entered the army for the express purpose of acquiring information for transmission to the enemy. These were, in plain language, spies, and had they been caught "with the goods," they would have been subject to court martial and execution. In order to silence the countless stories and rumors which have been circulated, I will avail myself of this opportunity to state that *not a single American soldier or civilian was executed for espionage during the entire course of the war.* The bulk of the cases which were investigated concerned men who, because of their foreign birth, or antecedents, or sympathies, *might* have been willing to impart information of military value to enemy agents. The most difficult class to deal with, however, was the man who was spreading stories, with or without thought as to their effect, which would tend to lower the morale of the army. The reports upon which investigations were initiated varied greatly in definiteness, ranging all the

way from specific statements as to a man's utterances or acts to a vague rumor that in such and such a place there was a man, name not given, who should be investigated. It was the policy of the section, however, to pursue any clew, no matter how vague, until the guilt or innocence of the suspect was definitely established. Where the original information was anonymous, that point was always sharply emphasized, so that the suspect's reputation might not be injured should the allegations prove to be unfounded, for it was found that anonymous charges were very frequently made from motives of spite or revenge or because of some real or fancied injury. In such cases it was the policy of the section to push the investigation only far enough to show their character and then drop them promptly, without burdening the field intelligence officers or other investigating agencies with useless work.

The converse of this policy was followed in cases where the charges appeared to be well grounded, the man then being kept under surveillance until something, no matter what, was picked up which would place him where he could do no harm.

One of the commonest problems was the one presented by the officer of German extraction who had been born and bred amid Teutonic influences, and who was naturally pro-German in sympathy and utterances before the United States entered the war, but who had been guilty of no act or utterance since that date which could be construed as in any degree disloyal, and who, from a military point of view, was extremely efficient. Such cases, in the last analysis, always resolved them-

selves into the question: "Is he fit to go across?" Each case was, of course, considered on its own merits. While it was obviously impossible to lay down a rule-of-thumb applicable to all, two considerations in the main governed the decision. In the first place, an effort was made to obtain the opinions of the officers serving with the man in question and to learn whether they would be satisfied to go into action against German troops with him. If his fellow officers felt that they could trust him under such circumstances, it was a fair judgment in his favor. The second consideration was to ascertain whether his name, lineage, or appearance would make him unacceptable to our French allies. If such were likely to be the case, international courtesy, if nothing else, made it inadvisable to send him overseas. Surveillance of these men naturally was continued in France, but the Intelligence Division of the A. E. F., in reporting that such a case could be considered closed, frequently said in effect that any taint of disloyalty which might once have existed had been burned away by the fire of battle.

The process of having an officer discharged from the army by authority of Paragraph 9, War Department Bulletin No. 32 ("The President is hereby authorized to discharge any officer from the office held by him under such appointment for any cause which, in the judgment of the President, would promote the public service"), was the easiest and most satisfactory manner of dealing with cases of individuals against whom it was impossible to obtain sufficient evidence for conviction by court martial but whose presence

in the army was regarded as constituting a menace to the national safety. This will explain in some measure, perhaps, the curt announcements which appeared from time to time during the course of the war in Army Orders: "Lieutenant (or Captain, or Colonel) So-and-So has been discharged for the good of the Service." The great drawback, however, to this method of ridding the army of undesirables was that it could not be applied to officers of the regular establishment, as the terms of the Act restricted its application to Reserve officers and those holding commissions for the term of the emergency. The policy pursued by Military Intelligence in the cases of regular officers suspected of disloyalty—for all suspected officers were not confined to the National Army or the Reserve Corps—was to have them assigned to posts where their opportunities for mischief would be reduced to a minimum. An officer ordered to duty in the heart of Alaska, say, was considered about as safe, from the point of view of Military Intelligence, as though he were in a cell at Leavenworth.

Among the nearly 700,000 men swept by the first draft into the cantonments to be fused into a national army were thousands upon thousands of men of alien birth, many of them but recently arrived in this country and all but ignorant of its tongue. It speedily became apparent that the fusing process was failing to produce in many of these men, perhaps in the majority of them, the change necessary to make them into soldiers. Instead of melting and flowing like the rest of the metal from which was forged the weapon which

halted the Huns at Château-Thierry and beat them back in the Argonne, these men of alien birth remained a hard, unyielding mass, not only obdurate in itself, but threatening to leave in the finished weapon flaws that would be fatal when it was subjected to the test of battle. By the fall of 1917, therefore, the military authorities had awakened to a realization of the fact that they were confronted by a serious and difficult problem—what to do with the foreign-speaking element of our new armies.

These immigrants, particularly the more recent, tend to congregate in the industrial centres of the country, in New York's teeming "East Side," in the mining regions of Pennsylvania, in the manufacturing cities of New England, and in the Pacific Northwest. Here they live in swarming communities, speaking their own languages, reading (if they can) their own newspapers, attending their own churches, their wants ministered to by their own doctors, lawyers, bankers, and tradesmen. From such colonies the drag-net of the draft drew into the army tens of thousands of foreign-speaking men. Here, then, was the first and greatest source of difficulty in transforming these aliens from many lands into American soldiers—ignorance of the English language. Unable to understand the orders which were given them, they were set down as stupid and surly, and through a lack of judgment in the selection of the commissioned and non-commissioned officers put in charge of them, they were frequently the victims of misunderstanding and ill-treatment. Four illustrations are typical of a hundred

or more similar incidents in the Depot Brigade at Camp Gordon:

Private Sobolowski, failing to spell his name, was struck in the jaw by his sergeant, so successfully that the jaw was broken and a few teeth were knocked out. The private went to the hospital and the sergeant to the guard-house, pending court-martial proceedings.

Private Pagarzelski replied to his corporal in Polish, which the corporal considered highly abusive. The private was court-martialled and sixty dollars of his pay was forfeited. As a consequence the man was not only unable to help his aged mother but was left without a penny for himself.

Private Sznyder, being on guard duty, misunderstood the orders repeated to him by the corporal of the guard, and naturally did not comply with them. As a result he was arrested and put in the guard-house, fifty-seven dollars being taken from him by a corporal, of which only thirty-five dollars was returned. The corporal took advantage of his ignorance of English to appropriate a part of the money.

A Russian was arrested for evasion of military service. After he had spent six weeks in the guard-house it was discovered (through an interpreter) that the man was arrested before he had received notification of being drafted.

From a counter-espionage point of view such conditions were distinctly dangerous. The foreign-speak-

ing soldiers, if not actually affiliated with the enemy, were, because of their ignorance and credulity, especially susceptible to the advances of enemy agents and propagandists. When herded together in a depot brigade, made surly by the inconsiderate treatment they received and chafing under the compulsion of being set at manual labor in this country when their ambition was to go overseas, they were potentially, if not actually, ripe for mischief.

Early in 1918 Mr. D. Chauncey Brewer, of Boston, president of the North American Civic League for Immigrants, was appointed by the Secretary of War to take the situation in hand. Under his direction a corps of field agents commenced operations both in the camps and cantonments and in the large cities and industrial centres, collecting information about the non-English-speaking men taken by the draft. These agents, who were carefully picked men of foreign extraction and generally linguists of ability, observed the general and special influences affecting the foreign-born groups and investigated propaganda, suspects, complaints regarding draft evasion, draft boards, soldiers' allotments, insurance, and the like. They reported on conditions existing in the camps from information contained in soldiers' letters, for many men who were prevented by their lack of knowledge of English or other reasons from complaining to their military superiors, would recite their troubles in their letters to the folks at home. These agents accounted in various ways for their presence in the camps, most of them announcing that they were working for the Associated Charities or

for the North American Civic League for Immigrants. They established connections with leaders of the foreign colonies in the larger cities as well as with the poor. The foreign-language press, its editors and its influence, good or bad, also demanded their attention. They reported loyal citizens of integrity and ability who were later induced by means of correspondence to volunteer for this kind of service and who could keep Military Intelligence informed on conditions in their respective cities when the agent had finished his work or found it advisable to withdraw. Thus was built up a large volunteer organization composed of loyal citizens of foreign birth or extraction, who kept the Intelligence Division advised of conditions among their respective groups or races, and to whom the division could apply for assistance or information in individual cases or localities. These volunteer assistants included men in all lines of business and in all professions. The Boards of Health of cities having large foreign-speaking populations vouched for loyal foreign-speaking doctors who, because of the peculiarly confidential relations they enjoyed with their patients, were able to obtain information of great value to the section. The same was true of clergymen of many denominations. The editors of foreign-language newspapers frequently rendered highly effective co-operation, and correspondence was started with a dozen or more school superintendents in the larger cities with a view to enlisting the aid of the high-school boys in promoting the morale of the foreign-speaking colonies.

Reports received from Camp Gordon in April,

1918, indicated serious trouble with the unnaturalized Russians and Poles, and, in some instances, with the Italians, all of whom were perfectly willing to fight for the lands from which they came but not for this one. Camp Gordon was a replacement camp, and as such had become a dumping-ground for divisions having men that they wished to get rid of, a large proportion of whom were foreigners. Of the 1,500 men of all nationalities who were transferred to this camp by the 82d Division on the ground of suspected disloyalty, nearly 1,000 did not speak English. In order to remedy this dangerous condition, a memorandum was drawn up by M I 3 and was adopted by the War Department. This memorandum recommended that foreign-speaking draftees not having sufficient knowledge of English to understand the commands be segregated by nationalities in companies, both the commissioned and non-commissioned officers of which should be of the same nationality as their men, or should at least be familiar with their language, habits, and psychology. In support of the plan the words of Napoleon were quoted:

"If I had enough humpbacks in the Army to make a regiment, enough Negroes to make a battalion, enough dumb men to make a company, I would so organize them. No stimulus is more potent than the pride of men who have a common bond either of race, nationality, color, or even affliction. Men thus put together want to show the rest of the Army their extreme capability."

The work at Camp Gordon was put in charge of an

officer of Military Intelligence, who had had considerable experience in social-service work among the foreign-speaking soldiers at Camps Grant and Custer. Upon his arrival at Camp Gordon he found that those soldiers (most of them foreigners) who had been left behind when troops were sent overseas had been placed in the 5th and 10th Training Battalions of the Depot Brigade. Forty-one nationalities were represented in this group of foreigners, classified as Allied Aliens, Neutral Aliens, and Enemy Aliens, 80 per cent of them being Italians, Slavs, and Russian Jews. The officer immediately initiated a study of each nationality and of each individual, the process of personally interviewing each man, 976 in all, occupying two weeks. Thousands of questions and complaints were answered and explanations made to the men in their native tongue, every man being recorded and classified according to his nationality, loyalty, intellect, citizenship, and military fitness. This done, two companies were formed, one composed of Slavs—the majority of them Poles—and the other of Italians. Three officers of Polish extraction and one of Russian were procured for the Slav company and two of Italian extraction for the Italian company. The first week of training and lectures on discipline resulted in an amazing impetus of spirit and enthusiasm. Between the Slavs and the Italians arose the keenest competition for proficiency in drill. So startling was the change that the battalion commander and the American officers in charge of the two companies passed rapidly from discouragement and pessimism to extreme enthusiasm. An elaborate plan was worked

out for giving the men a working knowledge of English and a series of lectures were given in their own tongues, thus acquainting them with the requirements necessary for service overseas. Special religious services were arranged for the Italians and the Slavs, their spiritual needs being ministered to by priests of their own faiths. The camp diet was modified in order to give them food which was racially acceptable. Social entertainments were planned, so that prominent citizens of Atlanta could meet the foreign-speaking soldiers and make them feel that they were as dear to the country whose uniform they were wearing as though they were American-born. The immediate result of this interesting experiment was the conversion of potentially dangerous malcontents into loyal, enthusiastic, and efficient soldiers. Furthermore, the reaction upon the families of the soldiers and upon the colonies from which they came was highly gratifying, for their letters from the men, filled with their suddenly awakened enthusiasm for army life and with glowing accounts of the kindness and consideration which were being shown them, did much to counteract any latent disloyalty among the foreign-speaking population. To each new group of foreigners who entered the battalion the question was put: "How many of you men are willing to go abroad and fight?" In most cases the affirmative responses were pitifully few. In fact, the Slavs practically all refused to put on identification tags, asserting that should they be sent abroad they would be as willing to help the Germans as the Allies. But when, after a few weeks' stay in the battalion, the question,

"How many of you men are willing to go abroad and fight?" was again put to them, the response was as remarkable as it was thrilling, for practically the whole battalion stepped forward as one man. Properly treated, the metal had fused at last. They were all Americans now.

So successful did the experiment prove at Camp Gordon that a few months later the same officer was ordered to introduce his plan at Camp Devens, where there were approximately 6,000 men who did not have sufficient knowledge of English to be effectively trained. In three days he, with proper assistance, personally examined upward of 2,000 men, and on the fourth day divided them into four companies, Company No. 1 consisting of 250 Slavs (three-fourths of them Poles), Company No. 2 of 230 Italians, Company No. 3 of 200 Greeks and Albanians, and Company No. 4 of the same number of Armenians and Syrians. A number of non-commissioned officers who could speak the necessary languages were transferred from the depot brigade and assigned to assist in the training of the new companies. The results obtained were beyond all expectations. The spirit and enthusiasm of the men advanced by leaps and bounds. They entered into competitive drills as enthusiastically as though they were schoolboys playing a game. The guardhouse, which, until the introduction of the plan, had always been full of foreign-speaking soldiers, suddenly became deserted. From being the worst organization at the camp, the "Foreign Legion," as it was called, became the model battalion.

The plan, followed both at Camp Devens and Camp Gordon, of providing the foreign-speaking organization with foreign-speaking non-commissioned officers of unquestioned loyalty served an additional purpose in that it provided the Intelligence Division with new and valuable sources of information, for the non-commissioned officers, being familiar with the language, customs, and modes of thought of their men, could easily detect any undercurrent of disaffection or disloyalty. Their common speech would at once establish a bond of sympathy that would be likely to disarm the suspicions of an enemy agent or sympathizer. Moreover, the speech and characteristics of peoples living in close proximity to each other, though divided by an international frontier, are usually so nearly identical that no one can distinguish between them save a person who himself comes from that region. Only a man who had himself lived on the Russo-German frontier, for example, would be able to say with certainty whether a certain soldier came from Russian, Austrian, or German Poland; from Galicia or Lithuania; from Transylvania, Besserabia, or the Ukraine. An incident which occurred at one of the camps illustrates this principle as applied to the Oriental races. A civilian agent of the Military Intelligence Division, who was an Armenian, noticed that a soldier who claimed to be a Syrian refused to eat pork. Being perfectly familiar with both Turkish and Syrian customs, and knowing that the Turks, who are Mohammedans, are forbidden to eat pork, while the Syrians, who are Christians, are not, the operative sharply

questioned the pretended Syrian, who at length confessed that he was a Turk, and, consequently, an enemy alien. Such a slight indication would have passed unnoticed save by one familiar with Oriental customs, and a dangerous enemy agent might thus have escaped detection.

To M I 4 was intrusted the extremely important work of counter-espionage among the civilian population. It investigated the activities of the enemy in propaganda, in sabotage, and in the establishment of communications with the home country; it investigated such of his trade activities and financial transactions as might impede our successful prosecution of the war; it discovered enemy influences among political, racial, and religious groups and in labor organizations, and it watched persons throughout the nation who, though not associated with the enemy, were nevertheless engaged in pacifist, revolutionary, and similar activities which were likely to interfere with our military operations. The section operated through many agencies. As a branch of the War Department, it employed intelligence officers serving with troops in the various camps and cantonments, who furnished the section with much valuable information relative to civilian activities which reacted upon the army. Similar information was furnished by the departmental intelligence officers, stationed at the headquarters of the several geographical departments of the army, and by the military attachés in foreign countries. The Department of Justice, the State Department, and the Office of Naval Intelligence also actively co-operated with

the section. By the establishment of a system of counter-espionage in foreign countries the section succeeded in frustrating many of the German plans at their source and in counteracting enemy propaganda which, had it gone unchecked, might have had the gravest results. The German method of organized propaganda was well illustrated by the operations of the Chilean-German League, which was founded in October, 1916, by Chileans of German descent, its membership including commercial agents, priests, professors, physicians, merchants, and school-teachers. In a circular dated Valparaiso, October 24, 1917, and marked "Confidential," the management of the local branch of the league at Valparaiso announced a meeting to be held jointly with the representatives of all German societies of the city for the purpose of founding a propaganda committee. The necessity for starting a propaganda on a large scale was pointed out, and the main object of the league, that of urging the maintenance of neutrality by the Chilean Government, was described in detail. The importance to the Allies of the German ships in Chilean waters was also emphasized, the circular saying, in part: ". . . if we succeed in postponing the rupture of relations by this propaganda only for weeks, we have aided Germany and her allies to the extent of millions, harming the Allies at the same time by millions." Though the league succeeded in preventing Chile from joining the Allies, the vigilance and energy displayed by the agents of our counter-espionage service in that country practically nullified the effects of the league's propaganda in South America.

From the beginning of the war until its end the American public was constantly thrilled by the sensational and usually highly circumstantial accounts which appeared in the press, particularly the Sunday supplements, of the operations of German secret agents in the United States. Every one, I suppose, has heard, in some one of its many versions, the story of the German spy who was shot in the telephone-booth of a New York hotel by a Secret Service operative while giving a confederate information relative to the sailing of American transports. Though I have heard that story related, with minutest detail, in clubs, over dinner-tables, and in the smoking-compartments of Pullmans, I never heard any one ask the quite obvious questions as to why it was necessary for the operative to shoot the spy instead of taking him alive, or how the confederate proposed to transmit the information to Germany. One picturesque version of the story laid the scene in a crowded New York Subway train, the Secret Service man having his automatic in his pocket and firing through the cloth of his coat. Then there was the equally sensational story of the Hoboken family in whose employ was a German spy disguised as a maid of all work. One day she mysteriously disappeared, and a few hours after her disappearance Secret Service agents called at the house and searched the belongings she had left behind her. Their search was rewarded by discovering, under a false bottom in her trunk, a complete set of the plans of the defenses of New York harbor. Variations of that tale placed its locale in Stamford, Conn., in Chittenango, N. Y., in Newton Centre, Mass., in Key West, and in Los

Angeles, while the papers discovered in the mysterious trunk ranged all the way from drawings of coast-defense guns to a copy of the German Naval Code. The same hysteria which led the public to accept these ridiculous concoctions at their face value, and to beg for more, caused them to suspect all sorts of well-known persons of being engaged in espionage activities—the general commanding a certain American division, a famous woman aviator, a still more famous prima donna, a Jewish banker noted for his philanthropies, the chancellor of a great university, and even the secretary to the President having been discovered—so the rumors had it—to be German spies. At one period of the war, indeed, it was popularly reported that spies were executed every morning at daybreak on Governor's Island. Now I dislike to destroy illusions and to spoil perfectly good stories, but the dictates of truth compel me to assert that not a single spy was executed on Governor's Island or anywhere else in the United States, though it is my personal opinion that a few such executions would have brought to an abrupt end the series of fires, explosions, strikes, and other cases of sabotage for which the agents of the Wilhelmstrasse were responsible. For stating this opinion, quite early in the war, at a dinner in Boston at which I was a speaker, I received a mild reprimand from the Adjutant-General of the Army. On the occasion in question I remarked, if I remember rightly, that I was convinced that the most effective method of dealing with spies was not to intern them but to inter them. And I am still of the same opinion.

Though Germany had a number of secret agents operating in the United States—though not nearly as many as was generally supposed—the only one of them who measured up to the popular conception of a spy was a woman known as Madame de Victorica. In certain respects she came very near to meeting the specifications for an international adventuress as laid down in the mystery stories of Messrs. Chambers and Oppenheim. The results she obtained were, however, distinctly disappointing—at least from the Wilhelmstrasse point of view. Her father was the Prussian general to whom Marshal Bazaine handed his sword at the surrender of Metz; her mother was a Prussian countess; her sister was married to a Prussian nobleman, and her brother was a Jesuit priest serving as a chaplain in the Austrian Army. Madame de Victorica has had three husbands—all South Americans. Two died within a few months after marrying the handsome adventuress; the third was divorced. According to her confession, Madame de Victorica was trained in espionage work at the Naval Intelligence Bureau in Berlin and was sent to the United States by the authorities of the Wilhelmstrasse for the purposes of obtaining military and naval information, to foment labor troubles, to tamper with the Roman Catholic clergy, and to lay the plans for a rebellion in Ireland more successful than the abortive one of 1916. She memorized a code before leaving Berlin. The secret ink in which her letters were written was given her at the Chemical Institute and was carried in two silk mufflers, the ink being obtained by

saturating them in cold water and wringing them. Writing in this ink could be developed with iodine tablets, manufactured by a well-known firm of London chemists, dissolved in vinegar. Other messages were transmitted by means of pin-pricking certain letters in newspapers. Madame de Victorica was unquestionably a woman of considerable intelligence and social position; she had had some experience as a journalist, and was apparently credited by the Germans with quickness of wit and resourcefulness as an organizer. This reputation she only partly justified, however, for she talked indiscreetly on the steamer while coming over, wasted time and money after her arrival in New York in buying elaborate gowns, and was an inveterate user of drugs. As the result of converging lines of inquiry pursued by Military Intelligence and the Department of Justice, she was arrested, together with several of her confederates, in August, 1918. There you have a thumb-nail sketch, as it were, of the most dangerous German agent in America. She can thank her lucky stars that the Wilhelmstrasse sent her to the United States instead of to France or England, for had she been caught in either of those countries her career would have ended not between stone walls but between a stone wall and a firing-party.

It is easy enough to understand, if not to sympathize, with the reasons which led Madame de Victorica to come to the United States in the capacity of a German spy, for she was, after all, German to the core, her relatives for generations before her having held high positions under the Prussian crown. But it is

not easy, indeed it is almost impossible, for a loyal American to understand how men who were born and educated in the United States and who had a long line of American ancestors behind them, could sell their honor and their loyalty for German gold. It is, however, a curious and regrettable fact that certain persons whose disloyalty was proved beyond the shadow of a doubt were purely American, so far as their birth and parentage were concerned, their only connections with Germany being financial ones. Of these I have particularly in mind three men, all, if I am not mistaken, possessing university educations, who were journalists and correspondents of considerable standing until the discovery of their pro-German activities blasted their reputations and plunged them into oblivion. One of them—a correspondent who had seen service in several wars—was caught in the act of carrying messages from the Austrian Ambassador in Washington to Berlin. He was arrested by British intelligence officers and returned to the United States. His passport was taken from him, and those who were once his friends now pass him by without speaking. Another of these gentry succeeded, in spite of his German sympathies and affiliations, in obtaining admission to a training-camp, being given a commission and sent to France. But, as the result of representations made by the Intelligence Division, which was thoroughly familiar with his career, he was brought back to the United States, subjected to an official interrogation, confessed, and, though he made desperate efforts to have the President accept his resig-

nation, was dismissed from the army "for the good of the service." The third of this precious trio went to Germany as a correspondent, at once constituted himself a champion of everything German, savagely attacked the land of his birth, and, upon the fall of the Kaiser, fled to Sweden, where, so far as I am aware, he is still living in exile, a real "Man Without a Country."

The great organization built up by Von Papen and his fellows for purposes of sabotage made it imperative, upon the entry of the United States into the war, that a system should immediately be devised for the protection of those plants and workers engaged in the manufacture of munitions. With the declaration of war the United States became, almost overnight, the greatest manufacturer of war materials in the world. In every city in the land factories producing the tools of the fighter's trade were running night and day, and other factories, hundreds of them, began to spring up as though at the wave of a magician's wand. The nation was a-hum with feverish industry from ocean to ocean. But of what avail was this tremendous wave of manufacturing activity, of what use the expenditure of billions in the erection and operation of plants and factories, unless those plants and factories were afforded protection against fire and the acts of enemy agents? To fill this need there was organized, in July, 1917, the Plant Protection Section of the Military Intelligence Division.

The system of plant protection provided, first of all, for a physical examination of the munition facto-

ries of the country with a view to minimizing the danger of their destruction by fire. Basing their plans on the estimates of the insurance companies that 85 per cent of all fires are the result of carelessness, the inspectors sent out by the section insisted, as a measure essential to the success of their work, on a systematic and wholesale house-cleaning, the wave of cleanliness which struck those American plants engaged in the manufacture of munitions during the first year of the war being directly traceable to the orders of the Plant Protection Section. The officers of the section next turned their attention to measures for the prevention of sabotage and the fomentation of labor troubles by enemy agents, which was accomplished by the introduction of what was known as the "interior organization system." This consisted in the establishment within the plant of a complete espionage system, composed of old and trusted employees, who worked as Secret Service agents, and were unknown to one another. In cases where it was deemed necessary, this body was reenforced by trained and experienced operatives from the Plant Protection Section, who usually obtained positions as workmen in the plant without the knowledge of the management. By this means the perpetrators of many cases of sabotage were discovered, incipient strikes were prevented, agitators and professional trouble-makers were kept under surveillance, and, if their actions warranted, were placed under arrest, and an unceasing watch kept on the movements of enemy agents. The campaign of sabotage and destruction which German sympathizers had been con-

ducting almost unchecked was abruptly halted, for so wide-spread and efficient was the section's organization that the enemy agent was constantly haunted by the fear that his most trusted confederate might be a secret operative who was watching his every action. Though it never had more than 400 active agents (this does not include, of course, the enormous number of volunteer operatives recruited from the workers themselves), the section extended its protection to more than 37,000 manufacturing plants, and, during the period of its war-time operations, made upward of 270,000 recommendations for arrests, investigations, and prosecutions, or for further plant protection.

Agents of the Plant Protection Section succeeded in gaining admission to the innermost councils of the I. W. W. and kindred organizations, and, by thus obtaining advance notice of any contemplated action, were successful in averting strikes and labor troubles which would have caused the loss of millions of dollars, and, through halting the flow of munitions to the front, the loss of thousands of American lives. The success of the section in this phase of its work was due, first, as I have already explained, to its ability to obtain advance information of impending trouble, and, secondly, to the fact that the agents of the section were in a position to handle a delicate labor situation in an absolutely impartial manner, taking no sides and inspiring the confidence of both employers and employees. Thus it came about that the section was frequently able to compose differences between capital and labor when other arbitrators, who did not so com-

pletely hold the confidence of both parties to the dispute, failed.

After the Armistice the activities of the section consisted, in the main, in protecting the government against fraudulent claims presented by manufacturers and in guarding the great plants and warehouses which were abandoned upon the cancellation of war contracts. In one case the section obtained and prepared evidence for a grand jury which so conclusively showed fraud on the part of certain manufacturers holding government contracts, that another concern, which had already presented claims amounting to $600,000, upon learning that they were being investigated by agents of the section, hurriedly withdrew them. Another example of the efficiency which characterized the work of the section is illustrated by the case of a concern engaged in the manufacture of shells, the evidence presented by the section resulting in the indictment of the president and ten other officials of the company for submitting shells to the government for inspection under fraudulent circumstances.

The difficult, perplexing, and highly delicate work connected with the various phases of the censorship was intrusted to the Tenth Section of Military Intelligence, a number of subsections being established for the censorship of mail matter, telegraphs and telephones, radio, books and permanent literature, foreign-language newspapers, religious and pacifist publications, photographs, motion-pictures, and mail to or from prisoners of war.

To assume censorship of the mails was a new experience to our government, for it was in direct opposition to American customs and traditions and was extremely repugnant to a large and influential section of the American people. It was undertaken, indeed, only after its necessity had been urgently and repeatedly emphasized by our allies. Early in the war France had taken over the censorship of the Swiss mails, leaving to England the supervision of the mails to and from Holland and the Scandinavian countries. Little attention had been paid, however, to the Spanish, Mexican, and Central and South American mails, save when they passed through the postal barrier erected by the Allied censorship around the neutral states of Europe. The first problem that faced the American censors, therefore, was to close the channels of information leading into Germany through Spain, or out of Germany, via Spain, to the Americas, Spain being in constant communication with Berlin by a powerful system of wireless. Upon our entrance into the war it became imperative to close this gap in the news blockade which was in force against the enemy. This done, the only possible way for a German sympathizer in the western hemisphere to communicate with Germany was indirectly, through an intermediary in a neutral country, it becoming necessary for a German agent in South America, for example, to direct his communications to some confederate in Holland or Scandinavia. Such communications, which were usually disguised as innocent social or business letters, but in reality contained concealed messages in code, cipher,

or invisible ink, would then be transcribed by the confederate in the neutral country and forwarded to the particular bureau of the German Government for which they were intended, either by special courier or through ordinary postal channels.

Owing to the peculiar position of the United States and its distance from the actual battle-front, about 95 per cent of its postal-censorship work was negative in character and only 5 per cent positive, these terms, "negative" and "positive," being used in the same sense as they applied to other activities of Military Intelligence. By far the greater part of the mail that required censorship was of a nature which might have caused social unrest, labor troubles, or even rebellion in this country. Only a comparatively small number of letters were intercepted which brought positive information concerning the plans of the enemy or of neutrals. In studying this positive information it was necessary for the censors to keep constantly in mind the fact that the enemy intentionally permitted false information to be sent out, which, were it taken at its face value, might lead us to alter our plans or to relax our efforts. For periods of two or three months, perhaps longer, immediately preceding each of the great German offensives, there trickled into the offices of the censor scores of letters depicting in heartrending terms the social unrest and the appalling food conditions in the Fatherland.

Early in 1918 the United States, following the example of France and England, established large chemical laboratories in New York and Washington,

where thousands of letters were subjected to tests for invisible ink. The usual letter-paper which is used for communications in invisible ink can be given minor tests without altering its appearance. These preliminary tests are for the purpose of ascertaining whether the paper has been moistened or subjected to other treatment preparatory to the use of invisible ink. In case the minor tests show the paper has received some unusual treatment, a major test is given which results in developing any invisible writing, though it at the same time affects the texture and color of the stationery so that it is impossible to restore it to its original appearance. Practically all mail to or from persons on the suspect lists kept by England, France, and the United States was subjected to such examination.

By assuming the censorship of the Spanish, West Indian, and Latin American mails, the American authorities were able to break up the trade relations which up to that time had existed between German sympathizers in the United States and German forwarding agents in South America. In the latter months of the war Germany found herself in desperate need of rubber in any form for use in electrical devices, particularly for the construction of electrical apparatus to be used in torpedoes and submarines. Hence we find the censorship intercepting suspicious orders for such goods as dental rubber, tobacco-pouches, rubber soles and heels. The censorship also intercepted and confiscated hundreds of tons of German propaganda literature prepared by German agents in Spain and intended for distribution in Latin America. Had this

propaganda reached the German agents in South and Central America to whom it was addressed and had it been distributed in accordance with their plans, it would unquestionably have resulted in great social unrest, political demonstrations, and revolutions, if not, indeed, in actual war between certain Latin American countries, thus interrupting our supply of certain products essential to the manufacture of munitions. Had the Germans, for example, succeeded in starting a war between Chile and Bolivia over the Tacna-Arica question, our supply of Chilean nitrates, which we imported in enormous quantities, in all probability would have been cut off. In fact, it was the likelihood of just such an occurrence which led us to spend millions of dollars in the erection of nitrate plants in the United States, thus making us independent of the Chilean nitrate beds. The censorship was likewise largely responsible for preventing revolutions which were planned to take place simultaneously in Cuba and Mexico. German agents had planned to launch a revolution in the Oriente province of Cuba with a view to burning the cane-fields, while at the same time an insurrection was to break out in the Tampico district of Mexico, thus providing an excuse for the destruction of the oil-wells. Had this plan been successful—and it came much nearer being successful than most persons realize—our main sources of supply for oil and sugar would have disappeared. But the plotters in Cuba were indiscreet enough to discuss their plans in letters sent to their representatives in the United States; these letters were intercepted by the

postal censors, and a few days later a transport, loaded to the gunwales with American Marines, set sail for Guantanamo. The commander of the Marines had orders to prevent the peace of the island republic from being disturbed. And he did. For which we—and the Cubans—have to thank the postal censors.

It did not take the government long to realize that, if the cable and postal censorships were to be made sufficiently water-tight to prevent our military secrets leaking through to the enemy, it would be necessary to reinforce them with a censorship of photographs and motion-picture films. Accordingly, the Censorship Section of Military Intelligence was charged, in addition to its numerous other duties, with the censorship of all pictures taken by military photographers for the use of the Committee on Public Information and for other publicity purposes, as well as of those taken for commercial purposes by private concerns. In order to keep our own people, as well as those of the Allied and neutral countries, acquainted with the progress which the United States was making in the business of war, scores of cameramen belonging to the Photographic Section of the Signal Corps were sent out, at the request of the Committee on Public Information, to take pictures at the cantonments, training-camps, and munition factories in this country and in the theatres of operations overseas. As, however, there were countless details of our equipment, munitions, training methods, and the like of which the enemy must be kept in ignorance, it was imperative that all such pictures be carefully examined and passed

upon before being released for publication or exhibition. And, moreover, they must be passed upon by men who were authorities on the various phases of the army with which the pictures dealt. That it was a matter which could not be left with safety to amateurs was emphasized by an incident which occurred in October, 1918, when the great Allied offensive was at its height. One Sunday morning the officers of the General Staff were astounded to see, in the illustrated supplement of a New York newspaper, detailed photographs of the new French howitzers, the very existence of which up to that time had been one of the most carefully guarded secrets of the Allies. The young officer who passed the pictures for publication explained that, not being an artilleryman, the howitzers looked like any other guns to him. A few weeks later the Staff was again surprised and angered to see another secret—the small tanks which were being manufactured in this country—revealed in the same paper. Here was another case of an officer having passed a photograph dealing with a subject of which he was ignorant. In order to prevent a repetition of such blunders, the Censorship Section arranged to work in close co-operation with the Chief Naval Censor and with experts in the offices of the Chief of Coast Artillery, the Chief of Field Artillery, the Chief of Ordnance, the Director of Military Aeronautics, the Bureau of Aircraft Production, the quartermaster-general and the surgeon-general, these experts being consulted in regard to all pictures relating to their respective arms of the service. With their assistance

a series of precedents was established and a set of regulations for the censorship of photographs was evolved. Among the pictures withheld from the public were those dealing with new inventions of military significance, such as radiotelephony; with all examples of military and naval camouflage, and with the various new types of artillery, especially those on tractor mounts. Such photographs as were not released were placed in the archives of the War College to become a permanent part of the pictorial history of the war, while those which were passed were turned over to the Committee on Public Information for distribution to the various agencies which were in a position to give them the greatest publicity. There was also an informal, intimate, and extremely valuable service which the section was able to perform. As pictures were received from the A. E. F., a systematic effort was made to furnish to the relatives and friends of soldiers serving overseas copies of the photographs or sections of the films in which their loved ones appeared, of the hospitals in which they were being treated, or of the spots where they were buried. As a result of this official thoughtfulness, comfort was given to many a lonely wife, many an anxious parent.

A no less important phase of the section's activities was the censorship of still and motion pictures taken for commercial use at home and abroad and the supervision of the firms and individuals taking them. When one remembers that "The Birth of a Nation" is estimated to have been seen by 60,000,000 people, a realization can be had of the enormous pos-

sibilities of the motion-picture for purposes of propaganda and the necessity of subjecting it to rigid censorship. Whenever a picture contained a suggestion of enemy propaganda, or when the policy of a producing company appeared to be antagonistic to the interests of the United States, a systematic investigation was started to determine the loyalty of the officers of the organization and the source of its financial backing. If the enemy propaganda was evidently intentional, steps were immediately taken to prosecute the producers under the Espionage Act. If, however, as was usually the case, the fault was due to mere ignorance or thoughtlessness, a conference with the persons concerned generally resulted in the alteration or withdrawal of the offending picture.

Exceptional precautions were observed in the censoring of films destined for export. This work was in charge of the Customs Division of the Treasury Department, the films being viewed by a board composed of representatives of the Customs, Military and Naval Intelligence, and the Committee on Public Information. If a member of this board made any objection to a film it was sent to the custom-house for review by another board of censors. If the matter to be deleted was unimportant, the objectionable parts were cut out in the projection room. If the film was approved, a letter of clearance was issued by the Committee on Public Information and an export license was then granted by the War Trade Board; should the film be rejected, the license was, of course, refused.

In censoring commercial films and photographs, every effort was made to prevent the export of pictures which might reveal the war secrets of the United States, which might be distorted and used as enemy propaganda, or which might give a wrong impression of the conditions prevailing in this country. For example, no pictures dealing with the influenza epidemic were permitted to leave the country, for the German Government would almost certainly have used them as proof that the man-power of America was seriously impaired, thus encouraging the German people to prolong their resistance. An export license was refused to a picture showing the effects of a cyclone in Tyler, Texas, because, had it reached Germany, it would, in all probability, have been given a caption something like this: "American city after bombardment by German aircraft." The fact that there were no German aircraft on this side of the Atlantic would have made no difference; the credulous German public would have greeted such a picture with wild applause. As a matter of fact, thousands of pictures of crumbling castles in England and of French ruins dating from the Crusades were used in such manner by the Germans. For a similar reason, the beautiful poster drawn by Joseph Pennell for the Fourth Liberty Loan, depicting New York City in ruins as the result of a raid by German aircraft, was not permitted to go abroad, for it would have been only too easy for the German Government to publish it as an official picture of the devastation wrought by German airmen in the American metropolis. I have wondered, indeed, why the

German propaganda bureau did not publish a picture of Pompeii with a caption to the effect that it was an Italian city destroyed by the Austrian fleet.

Some curious schemes were perfected by German agents in the United States to convey messages to Germany in spite of the censorship. A set of films depicting cannibal life in the South Seas aroused the suspicions of the censors because of the irregularity of the perforations and because of certain mysterious numbers appearing along the edges. The films were finally passed for export, but not until the perforations and numbers had been trimmed off. On another occasion the censor seized an advertising folder, issued by a famous New York department store, which contained a photograph of an exceedingly good-looking young woman wearing an embroidered blouse and a plaid skirt, such as the store was offering for sale. The picture showed the young woman standing beside a table, holding in one hand a volume which, upon close inspection, was found to bear the peculiar title *The Laborer's Catechism*. Some bright mind in the Censorship Section deduced that this title was really the key to a code message, and that the message itself was contained in the embroidery on the blouse. The story, which appeared to have all the elements of a first-class spy tale, was spoiled, however, by the unromantic code experts of M I 8, who professed themselves unable to find any message concealed in the embroidery. Both the department store and the photographers who took the picture were entirely absolved of any attempt to communicate with the

enemy, and the young woman herself was found in a hospital, desperately ill with influenza. When the agents of the Department of Justice visited the hospital some time later for the purpose of interrogating her, it was found that she had left for parts unknown. Whether the message was embroidery or imaginary I do not pretend to say. I merely repeat the story because it illustrates the extreme caution exercised by the Censorship Section. Knowing the cunning of the Teuton, it was taking no chances.

Speaking of false scents in the tracking of spies, I remember being told in England of an old lady, apparently a woman of some means, living in a suburb of London, who was accustomed to write several times a week to her daughter in Austria. The letters, being addressed to an enemy country, were, of course, opened by the censor. Though there was nothing in the communications themselves which could, by any stretch of the imagination, be interpreted as treason, the suspicions of the officials were instantly aroused by the discovery that each letter contained three new playing-cards. One letter might contain, for example, the ace of hearts, the ten of clubs, and the king of diamonds; in the next letter, posted a few days later, would be the seven and the nine of spades and the king of hearts. Here was a code which baffled every expert in the United Kingdom. British Intelligence, the Censor's Bureau, and the Criminal Investigation Department of Scotland Yard all tried to ferret out the mystery of the cards, but without success. Every conceivable test was applied to both the letters and the cards for

codes, ciphers, and invisible writing, but without an atom of success. At length the old lady, whose every movement had been shadowed for weeks, was summoned to Scotland Yard and questioned. When the chief inquisitor suddenly demanded of her why she enclosed playing-cards in her letters to her daughter, she replied: "My daughter is a great bridge-player, and when I read in the newspapers that it was impossible to get cards in Austria, I thought I would slip three or four cards into every letter. In that way, you see, I would be able to send her a pack every five or six weeks."

To another subsection of M I 10 was delegated the censorship of mail to and from the prisoners of war in the various internment camps in the United States. As there were nearly 6,000 of these interned enemies, and as they were permitted, by the regulations, to send nearly 40,000 letters and post-cards a month, no limit being placed on the amount of mail they could receive, the task of censoring this mass of correspondence, most of it in languages other than English, was very far from being a sinecure. The primary object of this censorship was to prevent the passing of objectionable communications, such as attacks on the government or information which might be of value to the enemy. The censors were also constantly on the watch to prevent the prisoners from acting as correspondence intermediaries; that is, from transmitting messages from Germany to German sympathizers in the United States, or *vice versa*. The kind of paper to be used by the prisoners for their corre-

spondence was selected by the subsection with a view to making difficult, if not impossible, the use of secret inks. Thousands of letters, both to and from the prisoners, were submitted to chemical tests for invisible writing, and hundreds of others, which aroused suspicion because of their peculiar wording or unusual marking, were examined for possible messages in code. One prisoner endeavored to communicate with his wife by writing in lemon-juice under the flap of the envelope, and at Fort Douglas a scheme was discovered whereby German sympathizers communicated with the prisoners by means of dots placed under the letters of words in newspapers sent into the internment camp.

In the days before the Great War revolutionized our customs and restricted the amazing liberty of action which we had enjoyed, it was as easy for any one who had the price of a ticket in his pocket to leave the United States as it was for him to leave his own dwelling. To-day—by which I mean the summer of 1919—it is about as easy for an American to leave the United States as it is for a convict to leave Sing Sing. This condition of affairs, so unfamiliar to Americans, is due to the barrier which has been thrown around these shores by rigid enforcement of the passport regulations of the Department of State in co-operation with the Passport Section of Military Intelligence. Prior to the passport regulations of September, 1918, no law of this country required an American travelling abroad to have a passport. In fact, the only countries where passports were needed were Russia and Turkey. But upon the breaking of

the war-cloud in the summer of 1914, passports were required everywhere, and the person who could not produce one upon demand, immediately became an object of suspicion and investigation. Under the regulations now in force, the Department of State, by its authority to exercise discretion in the issuance of passports, is in a position to control travel. And, thanks to the facilities of M I 11 for investigating the loyalty and character of applicants, the department is able to form a remarkably accurate opinion as to whether the applications it receives should be refused or granted.

It must be perfectly obvious that, had the old system of non-interference with travel been permitted to continue, German agents could easily have come to the United States through neutral countries, gathered such information as they required, and departed as they came. When war was declared on April 6, 1917, it was not necessary for Congress to pass a law restricting travel by alien enemies, for the law was already in existence, having been framed in 1798, at a time when France was our enemy instead of our ally, and handed down to us by the Fathers. As a result of the authority conferred by this forgotten statute, the German agent who counted on the law's delay, habeas corpus proceedings, and a long-drawn-out trial by jury, received the surprise of his life, for he found himself seized by a long, swift arm which, waiting for neither indictment nor trial, placed him where he could do no further mischief.

The seaman presented perhaps the most perplexing problem in the control of travel. He rarely remains

on the same vessel for more than a few voyages and he seldom has a real home where his antecedents can be looked up. Moreover, under the Seaman's Act, he is permitted, if not, indeed, encouraged, to desert in an American port in order to be re-engaged at the higher American rates of pay. So long as seamen from neutral countries, particularly those adjacent to Germany, could come ashore at will in American ports, no really effective control was possible. So, following the example of England and the advice of our military attachés in the countries of northern Europe, an order was issued by the Secretary of State—though not until seventeen days before the signing of the Armistice—forbidding seamen from neutral countries to leave their ships while in American ports. The presence of naval guards on the vessels insured the enforcement of the order, which was withdrawn, however, shortly after the signing of the Armistice.

By an arrangement with the State Department, all passport applications, both from citizens and aliens, are referred to M I 11 for investigation. The files of the Military Intelligence Division now contain a vast amount of information, much of it of a very detailed character, concerning persons and business firms in the United States and foreign countries. By referring to these files, therefore, or by directing its agents to make special investigations, it is an easy matter for the Passport Section to decide whether the applicant is the sort of a person to whom a passport should be granted. The passenger-list of every vessel bound for an American port is cabled to the Passport

Section by the American consul upon the departure of the vessel from the last port of call. These lists are checked in the suspect files of the Military Intelligence Division, and if there is found anything which makes a passenger objectionable or suspicious, the intelligence officer at the port where the ship will arrive is promptly notified, whereupon the passenger in question is either denied entry to the United States or placed under arrest, according to his nationality and other circumstances. A somewhat similar system of control is in operation along the Mexican and Canadian borders, the immigration and intelligence officers who are stationed in the towns along the international boundaries making it difficult, though by no means impossible, for undesirables to enter or leave the country. It will thus be seen that the Passport Section, aided by a small army of military attachés, consuls, customs officials, immigration officers, secret agents, and intelligence police, has succeeded in establishing a highly effective control of travel, thus preventing the entry or departure of persons whose expressions or actions might prove detrimental to the interests of the United States.

Military control of travel is, of course, a war-time measure, and with the passing of the emergency which gave it birth it will almost certainly disappear, along with most of the other activities of Military Intelligence. Though I am heartily in favor of completely restoring the country to a peace-time basis, and of abolishing the many highly arbitrary measures made necessary by the war, it seems to me that it

might be a good idea to continue some form of travel control which would prevent the entry into the United States of undesirable aliens. We have quite enough of them as it is.

VIII

"TREAT 'EM ROUGH!"

IT is rather a curious circumstance that the idea from which was evolved one of the most formidable weapons of the war, and one which proved a prime factor in bringing Germany to her knees, was obtained by an Englishman in Germany, from under the very noses of the Germans themselves, who did not have the vision to recognize its amazing military possibilities. About a year before the Teutonic wave surged across the frontiers of France, the representative of a California manufacturing concern was giving demonstrations in the larger German cities of a singular device known as the Holt caterpillar tractor. Though this contrivance, in spite of its grotesque and clumsy appearance, could cross ditches and surmount obstacles with amazing agility, it did not arouse particular interest among the Germans, for it was intended for the pursuits of peace, whereas they were even then seeking new means for making war. But it chanced that among the onlookers at one of the demonstrations was an English traveller, who had the imagination to see in the clumsy machine, as it waddled across an apparently impassable terrain with the relentlessness of fate, something more than an agricultural appliance. Upon his return to England he described the tractor to Colonel E. D. Swinton, who evinced the liveliest

interest in the subject, closely examining the pictures and asking countless questions. I might add that General Swinton, for he has since been promoted, has, unlike most professional soldiers, a highly developed imagination, as is shown in the stories he has written, the best known of which is entitled *The Green Curve*. Colonel Swinton, who had served in the South African campaign, had long had in mind an idea for an armored fighting-machine, a sort of small fort on wheels, which could be propelled by its own power over ground impassable to any other type of vehicle. The caterpillar tractor gave him the means of propulsion which he had been seeking. But, as might have been expected, the hidebound, brassbound officials of the War Office condemned the suggestion as fantastic and impractical, it not being until 1915, when the gloom of despondency overhung the land and people snatched at straws of hope, that Swinton's plans were taken from their pigeonhole for reconsideration and he was reluctantly given permission to show what he could do. Upon caterpillar tractors brought from America he proceeded to mount armored hulls built according to his own designs, the land battleships thus created being armed with both field and machine guns. They were tested under conditions of the greatest secrecy, the trials proving so successful that the construction of a considerable number was immediately authorized. In order that the public might obtain no hint of the true nature or purpose of these terrible new weapons they were referred to as "tanks," the impression being given that they were

intended for transporting water. Painted in dull colors and swathed in tarpaulins, fifty tanks were landed at Le Havre on August 29, 1916, and were moved up to the Somme front under cover of darkness. At dawn on September 15, everything being in readiness for the launching of the great Somme drive, they were entered in battle on a most astonished foe.

Though I saw one of the tanks in action on this occasion—it was named, if I am not mistaken, "*Crème de Menthe*"—I was not permitted to photograph it or to write about it. It has repeatedly been asserted that these tanks were the first vehicles of their kind in the history of warfare, and that is true, so far as the method used for their propulsion is concerned, yet it is interesting to note that, ten years before the Great Navigator set foot on the beach of San Salvador, Leonardo da Vinci had written as follows to the Duke Ludovico Sforza: "I am also building secure and covered chariots which are invulnerable, and when they advance with their guns into the midst of the foe, even the largest army masses must retreat, and behind them infantry may follow in safety and without opposition."

Everything considered, the tanks were not of much assistance to the infantry on the occasion of their first appearance, though they unquestionably caused considerable consternation in the German lines. Owing to delay in production, the British were obliged to employ at the battle of Arras, on April 9, 1917, tanks identical with those which had been used on the Somme and which were, in reality, fit only for training pur-

poses, having only 8-mm. armor. Nevertheless, two battalions were launched on a two-kilometre front, and there is no doubt that they rendered valuable service, the capture by twelve tanks of a German stronghold known as "The Harp" being a particularly noteworthy achievement. Eighty-eight tanks of an improved model, protected with 12-mm. armor, were used in the attack on Messines Ridge, June 7, 1917, but the success of the infantry was so complete on that occasion that the tanks had only an unimportant rôle to play. The torrential rains which fell during the early stages of the Ypres offensive on July 31 turned the battle-field into a broad and treacherous morass, in which tanks were of but little use. The following figures, which were doubtless as well known to Hindenburg as to Haig, explain why the tanks did not sweep everything before them, as it was confidently expected that they would do, and why the Germans were no longer particularly alarmed by their appearance:

	Battle of	Tanks in action	Ditched	Hit by shells
First day's fighting..	Arras	60	33 (55%)	7 (2%)
	Messines	88	7 (19%)	4 (5%)
	Ypres	133	60 (45%)	37 (28%)

It was my understanding at the time that the use of tanks by the British during the fighting on the Somme caused great annoyance to the French High Command, it being asserted that the British had agreed not to make use of their machines until the tanks which the French had under construction were ready, when

both armies would make a combined tank attack on a large scale. How much foundation there was for this assertion I do not know, but perhaps it was as well that the British tanks made their début when they did, for the French did not make use of tanks until April 16, 1917, when 132 Schneider tanks attacked between Rheims and the Aisne. "In spite of the congratulations of the commander-in-chief," reads a French report, "the results did not meet expectations, although wherever tanks were used they led the infantry beyond the advance of the rest of the front of attack."

It would seem that it was not until the British victory at Cambrai, when 430 tanks were used to lead a large attack, in the course of which 8,000 prisoners and 100 guns were taken, that the German High Command realized that the use of tanks could no longer be postponed, for shortly thereafter the German Tank Corps was formed, an Antitank School of Instruction was established, and orders were placed for a large number of antitank rifles. The Germans experienced numerous manufacturing difficulties, however, in the construction of their tanks, and when Marshal Hindenburg inspected the first fifteen *panzerkraftwagens*, as they were called, at Charleroi, in March, 1918, he damned them with the faint praise: "They probably won't be of much use, but since they are made we might as well employ them." This discouraging send-off apparently had its effect, for the original of the *Elfriede* type—*Elfriede* herself—was ditched and captured near Villers-Brettoneux a few weeks later. By

contriving to unite in this one model all the faults of the British and French tanks, the Germans once again proved the truth of the old saying: "Success has many imitators, but sometimes they copy only her defects." According to a German deserter, the German Tank Corps in July, 1918, consisted of 25 German tanks and 50 repaired British machines. This same authority stated that 250 light tanks had been ordered for delivery in September, 1918, and that in April construction had been begun on a monster 38 feet long, weighing 110 tons, carrying four 77-mm. cannon and 13 machine-guns. This formidable war-engine, called a "*Fahrbarer Sefechtsunterstand: ver dunden mit Artillerie unt Infanterie Beebachtung*," boasted contrivances for creating artificial mists (probably similar to our own smoke-producing devices), for laying and covering its own telephone-wires en route, was equipped with wireless, and carried a crew of an officer and twenty-eight men. If this supertank was ever constructed, it certainly never went into action.

The Germans were more successful, however, when it came to devising protective measures against tank attacks. These consisted of trenches of peculiar construction and design, some of them from 15 to 20 feet wide and 6 to 8 feet in depth; "tank traps," consisting of deep pits with camouflaged covers; bridges so built as not to support a tank's weight; mine-fields; special tank observation-posts; *Tank Goschutz Batterie*, as the Germans called their groups of 77-mm. antitank cannon; 55-mm. tank batteries, which were kept in pits about a thousand metres from the front line and

were only brought up when tanks were signalled; trench mortars mounted for horizontal fire; machine-guns firing armor-piercing bullets; hand-grenades with concentrated charges, and antitank rifles. The antitank rifle was a single-shot Mauser, mounted on a bipod, weighing 32 pounds and firing an armor-piercing ball of 13-mm. caliber. At close range this weapon penetrated the British heavy and the French light tanks. Had it been used in groups it might well have proved extremely formidable, but the unpopularity it enjoyed because of its heavy recoil combined with a well-founded reluctance on the part of its users to await the near approach of a tank, in a large measure neutralized its effectiveness. Toward the close of the struggle it seems to have fallen into general disuse, and when the Armistice was signed the enemy was preparing to supplant it with a 22-mm. machine-gun, a few of which had already been used with considerable success.

When the United States entered the war in April, 1917, the value of the tank as a weapon of offense had been so thoroughly established that steps were immediately taken to form a tank organization of our own, a special regiment—the 65th Engineers—being raised for the purpose. The units of this regiment were recruited at Camp Upton, New York; Camp Devens, Massachusetts; Camp Meade, Maryland; Camp Lee, Virginia, and Camp Cody, New Mexico, the entire regiment being assembled in March, 1918, at Camp Colt, on the battle-field of Gettysburg, which then

became the general concentration and preliminary training-camp for the tank organization. The tanks passed from the control of the Corps of Engineers on March 6, 1918, when the Secretary of War directed the organization of the Tank Corps as a separate arm of the service, Lieutenant-Colonel Ira C. Welborn, a regular infantry officer, being commissioned as colonel and appointed director of the Tank Corps in the United States.

The structural organization of the corps, as it existed at the close of the war, consisted of General Tank Headquarters, with 15 officers and 60 men; Army Tank Headquarters (one for each field army), with 7 officers and 27 men; Brigade Headquarters, 4 officers and 47 men; a Heavy Battalion, with a strength of 68 officers and 778 men; a Light Battalion, consisting of 20 officers and 375 men; a repair and salvage company, 4 officers and 146 men; a Depot Company, 4 officers and 138 men. To each Army Tank Headquarters were assigned 5 brigades, each brigade being composed of 3 battalions, 1 heavy and 2 light, and 1 repair and salvage company. A battalion consists of three companies, each company having three platoons. As five fighting-tanks are assigned to each platoon, it will thus be seen that a field army has 675 tanks at its disposal.

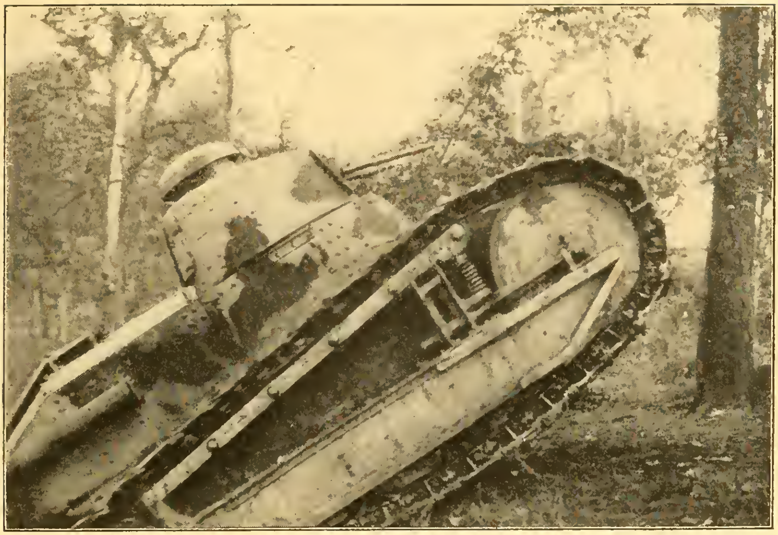
The commissioned and enlisted personnel of the Tank Corps was of as high an average, both mentally and physically, as any organization in the army, not even excepting the Air Service. About 65 per cent of the corps were technically trained men—engineers

and machinists—while the remaining 35 per cent was composed of business and professional men, farmers, cow-punchers, college undergraduates, and soldiers of fortune. They came from every section of every State in the Union. Their versatility was denoted by the pipings of their overseas caps—blue, red, and yellow—which denoted that they combined the functions of infantry, artillery, and cavalry. Several other colors might appropriately have been added, however, for the tank men were as familiar with Browning, Lewis, and Vickers as the machine-gunners, they knew as much about gas-engines as the Motor Transport Corps, they were as competent to make repairs as the men of the Ordnance Department, and in action they took as many risks as the youngsters on whose breasts were embroidered the silver wings. They were as keen as razors and as hard as nails. They were, to use the phraseology of the plains, fairly "rarin' to go," and they were ready and anxious to fight at the drop of the hat. In fact, that was why they joined the Tank Corps—because they believed it offered more opportunities for Boche-killing than any other branch of the service.

The training of the tank units was based on infantry drill, which is the best means of instilling discipline. This was supplemented, however, by instruction in the use of machine-guns and tank cannon and in the operation and maintenance of gas-engines, the men finally being brought to a point where they were ready to take up technical and tactical tank training at the British and French tank-training centres, to

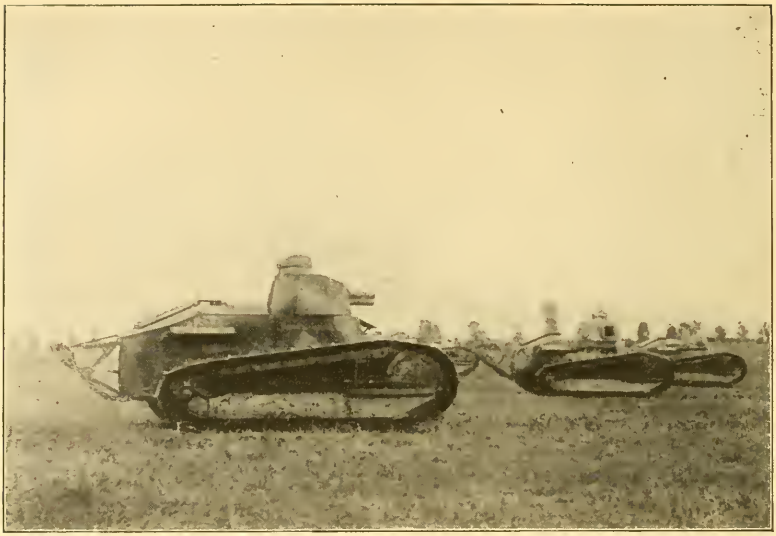
which they were sent as soon as there was accommodation for them. Thousands of men, trained to the limit of the facilities in this country, were held at Gettysburg from April and May until August and September because of the shortage of tanks and the lack of training facilities in France. Not until September, in fact, did any tanks become available for training purposes in the United States, when there arrived five British heavy tanks and several light tanks of American manufacture, thus permitting training to be resumed on a larger scale. When the Armistice was signed, the Tank Corps had a total of 20,212 officers and men, of whom 8,183 were serving in Europe. Shortly before the collapse of Germany preparations had been begun for the great Allied drive planned for the spring of 1919, steps being taken to increase the corps to a point where it could supply tank units for four field armies. The proposed strength for this purpose was 57,940 officers and men, it being planned to have this entire force fully organized, trained, equipped, and in France by the early spring of 1919.

The programme of tank construction for the American Army was initiated in February, 1918, but, owing to the extensive arrangements which had to be made with numerous manufacturers for the enormous number of parts required, and to the fact that there existed in the United States little or no accurate data regarding tank construction, the first light tank was not delivered to the Tank Corps in the United States until the following September. Owing to the more complicated mechanism of the heavy tanks, none of



THE AMERICAN WHIPPET TANK.

THE MARK V TANK.



Photograph by Signal Corps, U. S. A.

A SQUADRON OF WHIPPET TANKS ADVANCING IN BATTLE FORMATION.

Photograph by Signal Corps, U. S. A.

A SQUADRON OF WHIPPET TANKS PARKED AND CAMOUFLAGED TO CONCEAL THEM FROM ENEMY OBSERVATION.

them was completed before the signing of the Armistice. The machines used by the American Tank Corps units engaged on the Western Front were supplied by the French and British, no American-built tanks being employed in active fighting during the war.

After a series of conferences between American, French, and British tank officers, it was decided that two types of tanks should be manufactured in the United States: a heavy mode l(Mark VIII) and a light machine (Mark I) known as a "whippet." The heavy tank, which weighs thirty-five tons and carries a crew of one officer and nine men, is armed with two six-pounder rapid-fire guns and six Browning machine-guns, and is capable of a speed of from four and one-half to six miles an hour over ordinary ground. The whippet, named after a breed of small dog used in England for racing, was an adaption of the French Renault tank. It weighs six tons and carries a crew of two men—a driver and a gunner—and over ordinary ground can move at a speed of from seven to eight miles an hour. These, then, were the two types of tanks originally decided upon, but, as will be seen, the programme was considerably altered.

When it was decided that the United States should embark on a programme of tank construction, the Ordnance Department had only the haziest instructions to guide it. Owing to the mystery in which the French and British enshrouded the details of their tank construction, all that our Ordnance officers knew about a tank was that it should be able to cross trenches at least six feet wide, that it should be pro-

tected with armor-plate approximately five-eighths of an inch thick, and that it should carry one heavy gun and two or three machine-guns. Two experimental machines were laid down and work started on them at once, these models being intended to develop the possibilities of the gas, electric, and steam systems of propulsion as well as to ascertain the relative advantages of very large wheels and a specially articulated form of caterpillar tread.

At this time the British were using and were interested in a large tank only. The French had been using a medium-sized tank, known as the Schneider, but, as it had not been wholly successful, they had developed a much smaller two-man machine, called the Renault, which presented some very decided advantages and which they eventually adopted as their only type. While the large British tank had been reasonably successful in operation, it had certain very decided limitations which the British themselves recognized, so, after a thorough investigation of its possibilities and shortcomings, it was decided to redesign the large tank rather than to copy the existing model with its admitted defects. It was furthermore decided that the work of designing should be done jointly by British and American engineers, acting under the Anglo-American agreement drawn up as the result of a conference at British General Headquarters, which provided for the joint production by England and the United States of 1,500 large tanks, England to furnish the hulls, guns, and ammunition, the United States to provide the power-plant and driving mechanism.

When the Armistice was signed, approximately 50 per cent of the work represented by the American components had been completed, and it was confidently expected that the entire programme of 1,500 would have been completed by March. England had about 250 of the hulls ready when the Armistice was signed.

The work of manufacturing the French type of tank had not progressed satisfactorily, however, this being partly due to the delay involved in changing all drawings from the metric system to the American, and to the difficulty which was experienced in inducing American concerns to take on the production of this machine, which is extremely complicated and difficult to manufacture. It was necessary, therefore, to divide up manufacturing activities on this tank between a considerable number of plants. The original programme called for 4,440 of these small tanks, of which 209 had been completed by the end of December, 1918, with 289 more partly completed and production just getting under way. There was every reason to believe that the entire number would have been ready for use by April, 1919.

During the last summer of the war two new types of tank were developed. One of these was a two-man, three-ton affair, which the Ford Motor Company guaranteed to produce at the rate of one hundred a day. Orders were placed with that concern for 15,000 of these "flivvers" and the first 500 machines would have been ready for delivery on January 1, but upon the signing of the Armistice their production was

stopped. The other machine was a successor to the French Renault, but designed with a view to quantity production. It carried three men instead of two and was armed with both a 37-mm. cannon and a machine-gun, whereas the Renault carried only two men and one weapon. The cost of production would have been very much less than the Renault machine and the weight substantially the same. One thousand of these had already been ordered and negotiations were pending for a second thousand—the first to be delivered in January and the entire two thousand by the end of March.

In addition to the above activities, the Ordnance Department had decided to build 1,450 of the large Mark VIII tanks, including hull, guns, and ammunition, entirely in this country. In fact, work on the interior components for this lot of machines was well under way when the Armistice was signed.

It was perhaps as well for the Germans that they contracted yellow fever when they did, for had the war continued long enough to permit of America launching the avalanche of tanks which she had under construction, the Huns certainly would have had heart-failure. I doubt, indeed, if any Americans, save the handful of officers directly concerned, realize how tremendous was our tank programme. When the war ended, orders had actually been placed for 23,390 tanks, representing an outlay of approximately $175,-000,000. This vast fleet of tanks was to be manned by some 58,000 men—as many as there were in the entire American Army prior to the war with Spain.

Had these tanks been placed side to side they would have formed a moving wall of steel forty miles long. Even the comparatively few Tank Corps units which had an opportunity to get into action gave the enemy a taste of what we were preparing for him. Their crest was an angry cat. Their motto was "Treat 'Em Rough!" And they did.

IX

"GET THERE!"

IT may be said, without taking undue liberties with the truth, that the newest branch of the American Army, the Motor Transport Corps, owes its existence to a Mexican bandit named Francisco Villa, sometimes called "Pancho" for short. You may have heard of him. Though the officers who wear on their collars the insignia of the wheel and the winged helmet will probably disagree with this statement, asserting that their corps is an outgrowth of the Great War, it is, nevertheless, a fact that the present huge organization, which controls all the motor-driven transport of the American Army, had its beginning in the handful of trucks, barely a score in all, which ploughed their way across the sands of Chihuahua in the wake of Pershing's little punitive column.

When Villa and his raiders swooped down upon the border settlement of Columbus on the night of March 8, 1916, there was not a single organized motor-truck unit in the army, our officers, most of them trained in the schools of Indian and Filipino warfare, insisting that no motor-driven vehicle was as sturdy and dependable as the old-time escort wagon and its four-mule team. The refusal of our staff authorities to recognize the advantages of motor transport is the more difficult to understand when it is remembered that for close on four years there had been unfolding before our

eyes the countless object-lessons of civil life and of the war in Europe, every highway from the North Sea to the Alps being crowded with the motor-driven vehicles of the fighting armies.

The present Motor Transport Corps may be said to have been born when, three days after the Columbus raid, General Funston, in command of the Southern Department, telegraphed to Washington for authorization to form a number of motor-truck companies for service with the punitive expedition. The War Department acted promptly. The request was immediately approved, and within three days twenty-four trucks had been purchased, a force of civilian drivers had been recruited, and the entire outfit loaded aboard special trains. As soon as the trains reached Columbus the trucks were loaded with supplies and sent across the border to overtake the expedition, which was already well into northern Mexico. Notwithstanding the total absence of anything resembling roads, despite the deep sand, the extreme heat, and the inexperience of the drivers, the trucks caught up with the column before the supplies which it had taken from the United States were exhausted. From that moment the value of motor-driven vehicles for military purposes was firmly established in the minds of American officers, even the most hidebound old Indian fighters, who disapproved of everything new on principle, being compelled to admit that the mule must give way to the motor.

The first two motor-truck units proved so extremely efficient that the organization of others was begun, and by June 30 there had been formed fifteen

companies in all. The personnel of these early motor-transport companies was civilian, the drivers and repair men being provided by the factories which supplied the trucks, but it quickly became apparent that the employment of civilians would not prove satisfactory because of their lack of discipline and the consequent difficulty of keeping them under control, the officers not knowing how to handle civilians. So, whenever possible, enlisted men who had had experience with motor vehicles or who possessed some mechanical aptitude were transferred to the truck companies to replace the civilians, the latter remaining on to give instruction in driving and maintenance. Maintenance is, I might add, perhaps the most important factor in the successful operation of motor vehicles, for broken-down cars must be repaired, worn parts must be replaced, and the vehicles must frequently be overhauled. In order to maintain in a state of efficiency the truck trains operating in Mexico, it was found necessary, therefore, to build repair-shops and to organize repair crews. Though the personnel of these shops, like the drivers, was at first largely civilian, it, too, was gradually replaced by enlisted men, so it may be said that by the opening of 1917 motor transportation had become a recognized branch of the military establishment, although it was not until some time after declaration of war that it was authorized for the army.

Although, upon our entry into the European war, preparations were immediately begun for the complete motorization of the various trains—ammunition,

engineer, sanitary, and supply—which comprise the divisional trains, each of these sections was still controlled by the corps or department to which it pertained. In other words, the ammunition trains were controlled by the Ordnance Department so far as the procurement of vehicles and the supply of personnel was concerned; the engineer trains were under the control of the Corps of Engineers; the sanitary trains were under the Medical Corps, and only the supply trains came under the jurisdiction of the Quartermaster Corps. It must be understood, however, that the divisional trains were assigned to and became a part of the division itself, being, therefore, under the direct command of the divisional commander. As might have been expected, this system resulted in inefficiency and confusion because of municipal officers in control. Instead of all motor activities being directed by a single head, each of the staff departments using motor vehicles had its own ideas and worked along its own lines. Thus, the Corps of Engineers had designed and was manufacturing various types of vehicles adapted to engineering work. The Signal Corps was producing vehicles designed for carrying radio equipment, photographic laboratories, and the like. The Medical Corps was experimenting with various types of ambulances, dental wagons, and mobile laboratories, while the Ordnance Department was dividing its allegiance between the tractor type and the model known as the "Quad" or four-wheel drive. Thus it was that for many months after the declaration of war the motor activities of the army were distributed among several arms of the ser-

vice, with the inefficiency and duplication of effort which invariably results from decentralization.

The necessity for a separate organization to handle motor transportation was first recognized by the A. E. F., and in December, 1917, General Pershing issued a general order creating a Motor Transport Service. The new service was described as a part of the Quartermaster Corps, and an assistant to the Chief Quartermaster was detailed as its chief. For all practical purposes, however, it became a separate organization. In the United States the transition was more gradual, it not being until August, 1918, that the Secretary of War authorized the creation of a Motor Transport Corps as a separate and distinct branch of the military establishment, Colonel Charles B. Drake, who was later made a brigadier-general, being named as its first chief. The new organization was built up along the same lines as the Motor Transport Service, the officers and men of the latter being transferred to similar positions in the new corps, thus enabling them to continue the performance of their duties without interruption or confusion. The effect was as though the Motor Transport Service was lifted bodily out of the Quartermaster Corps, renamed, and made completely independent, the only visible sign of the change being, however, that the officers and men changed their Quartermaster insignia for the winged helmet superimposed upon a motor-wheel which was adopted as the device of the new corps.

Under the new order all the motor transportation of the army, save only tractors used for artillery pur-

poses, was embraced in the Motor Transport Corps. The Medical Corps, the Engineer Corps, the Quartermaster Corps, the Signal Corps, and the Department of Military Aeronautics, all of which had developed special types of vehicles for their respective needs, immediately turned over their equipment to the new organization. The designing of bodies was left to the several branches, but the designing of all types of chassis was included in the functions of the Motor Transport Corps. Among the duties of the new corps were the design, procurement, storage, maintenance, and replacement of all motor vehicles, though a few weeks later procurement was assigned to the Purchase, Storage, and Traffic Division of the office of the Quartermaster-General, with the proviso, however, that the Motor Transport Corps should prescribe the type and design of the vehicles supplied to it. The corps was thus enabled to insist that it be supplied only with the standardized military truck, the design of which had been achieved by the Motor Transport Service in spite of much opposition and after untiring effort. This arrangement also effectually prevented the purchase and use of vehicles of many different designs and put an end to the complicated and extravagant system of spare parts and supplies inseparable from the use of a multiplicity of types.

I might mention, in passing, that in the spring of 1917, just prior to our entry into the war, the automotive engineers of the United States met in Washington and, putting aside all thought of commercial rivalry or profit, or, indeed, of everything save patriot-

ism, designed a motor-truck which combined the best features of the many trucks which were then being manufactured, placing at the disposal of the government designs and patents that were the result of heavy expenditures of time, money, and talent. This work of standardization was in charge of Mr. Christian Girl, who was probably better fitted for the task than any man in the United States. The result was a standardized military motor-truck which is generally admitted to be the most efficient vehicle of its kind in existence.

The efficiency of any motor-transport service, no matter how well equipped with vehicles, must depend primarily upon the efficiency of its personnel. The finest truck that mechanical genius can design and money can buy can be ruined in a few hours by the carelessness or ignorance of its driver. It was quickly realized, therefore, that, if the Motor Transport Corps was to give efficient service, its officers and men must be as carefully trained as their fellows in the combatant branches of the army. The first real training-school for Motor Transport officers was established by General Pershing in France, its students being recruited mainly from Americans who had gone overseas prior to our entry into the war and had entered the French service as camion and ambulance drivers. These men possessed much practical knowledge, gained in actual warfare, and a large percentage of them were given commissions in the Motor Transport Service of the A. E. F. The chief training-centre in the United States was at Camp Joseph E. Johnston, on the St. John's River, near Jacksonville, Fla., and a smaller one was

later organized at Camp Meigs, in the District of Columbia. Using as a basis of instruction the curriculum adopted by the A. E. F., the officers and men at these camps were given a very thorough course of training in all phases of motor-transport work, including road-training, tactics, maintenance and repair of cars, and a certain amount of infantry drill in order to inculcate discipline. But with the growth of the army increased training facilities became imperative, it being estimated that between 20,000 and 30,000 men per month would be required by the Motor Transport Corps. In fact, requirements from overseas for men for operations up to July 1, 1919, was placed at upward of 231,000 officers and men. In order to train these men and organize them into the proposed units, it was planned to establish motor-transport training-centres at Camp Bowie, Texas; Fort Sheridan, Illinois; Camp Frémont, California; Camp Wheeler, Georgia, and Camp Taylor, Kentucky, which, in conjunction with the schools already in operation at Camp Joseph E. Johnston and Camp Meigs, and other schools which had been established by the Committee of Education and Special Training, would have given a total monthly training capacity of 23,800 men. The signing of the Armistice put an abrupt end to this enormous training programme, but plans have already been perfected for the formation of a Motor Transport Reserve Corps, which, it is believed, will result in providing a large number of officers trained in motor-transport duties and ready for immediate service in the event that the United States should again go to war.

About six weeks before the signing of the Armistice a spectacular campaign was inaugurated in order to obtain for the corps recruits possessing the necessary technical and mechanical training. Officers and civilians were sent to the principal cities in the United States to open recruiting offices, though no funds were appropriated for office rent, clerical hire, supplies, or advertising, each recruiting officer being expected to exercise his ingenuity in procuring all of the above without cost to the government. But thanks to the co-operation and assistance rendered by the local Chambers of Commerce and Boards of Trade, and to the patriotism of the automobile manufacturers and newspapers, the campaign proved, in spite of the lack of funds, a remarkable success, there being received more than 50,000 applications for enlistment.

Shortly after the beginning of hostilities steps were taken toward the establishment of three great motor-transport centres: Camp Holabird, about twenty miles from Baltimore, on the shores of Chesapeake Bay; Camp Jessup, at Atlanta, Ga., and Camp Normoyle. The huge assembly and repair shops erected at these camps are perhaps the most complete plants of their kind in existence, being of permanent construction and adapted to the needs of the army for many years to come. At each of these camps storage facilities have been provided for the vast number of motor vehicles which will not be required under peace conditions, but which will be kept in constant readiness for use in an emergency. Practically all motor vehicles destined for service overseas passed through Camp

Holabird, where they were uncrated, assembled, put in thorough running order, inspected, registered, and finally loaded aboard ship for transport to France. During the last summer of the war, when the shipment of motor vehicles was at its height, Camp Holabird was worth journeying a considerable ways to see, there being literally acres of vehicles, ranging all the way from huge artillery repair trucks, veritable machine-shops on wheels, to "flivvers" which unsuccessfully attempted to conceal their identity beneath coats of olive-drab. The paint-shops were, incidentally, one of the most interesting features of the camps, the paint being sprayed on the vehicles by means of air-brushes and a hose in little more time than it takes to tell about it. Thanks to this ingenious method, it did not take very much longer to paint a motor car or a truck than it does to polish a pair of shoes. Then there were the trimming-shops, where tops, curtains, boots, and cushions were turned out by the thousand; the supply depots, whose huge steel and concrete buildings were stacked to the ceilings with incredible quantities of tires, tubes, lamps, and other accessories; the repair-shops, with their forges, lathes, and travelling cranes; and the spare-parts department, where, thanks to a remarkably ingenious card-index system, there could be obtained without confusion or delay any duplicate part that might be called for, whether it was a new rear axle for a mobile repair-shop or a tiny cotter-pin for a motorcycle. Though these great shops had been in operation only a few months when the war ended, and though their personnel had been obtained anywhere,

everywhere, almost at a moment's notice, they were probably, everything considered, the best organized and most efficient plants of their kind in the world.

The Motor Transport Corps naturally resolves itself into two main branches: Park Service and Field Service. The first of these branches is subdivided, in turn, into four general types of parks: Reception, Organization, Replacement, and Repair. The Reception Park was usually established at, or near, a base port for the purpose of receiving motor vehicles for shipment abroad. Here the vehicles were uncrated, assembled, registered, and put in running condition. This done, the vehicle was sent on to an Organization Park, where vehicles and men first met, the latter coming from one of the Motor Transport Corps schools; here the various units were organized, and the personnel and material held in readiness for assignment. The function of a Replacement Park is, as its name signifies, to fill any deficiencies in equipment or personnel. Though this scheme of organization was quite generally adhered to in the A. E. F., each camp in the United States devoted to motor-transport activities may be said to have combined the functions of Reception, Organization, and Replacement Parks under a single head.

The present organization of the Field Service units of the Motor Transport Corps is as follows: the personnel of a motor-transport company consists of a first lieutenant, a second lieutenant, eight sergeants, forty-four privates (ten first-class), and two cooks; the equipment consists of a light open motor-car, a

Photograph by Signal Corps, U. S. A.

MOBILE MACHINE-SHOP OPERATING IN A VILLAGE UNDER SHELL FIRE.

Photograph by Signal Corps, U. S. A.

SUPPLY OF MOTOR TIRES.

Photograph by Signal Corps, U. S. A.

A MOTOR-CAR WRECKED RETURNING FROM THE FRONT LINES.

This means a job for the wrecking crew.

motorcycle with side-car, twenty-nine cargo trucks, including one for light repair and one for company supply, two tank trucks, and a rolling kitchen. A motorcycle company has a first lieutenant, a second lieutenant, six sergeants, a corporal, thirty privates, first-class, and a cook, together with thirty-two motorcycles with side-cars, and two cargo trucks. A headquarters motor command is in charge of a captain, who has two first lieutenants, a second lieutenant, five sergeants, four corporals, and two privates, first-class; the rolling-stock includes two heavy motor-cars, two light closed cars, one light open car, one cargo truck, and two motorcycles with side-cars. Though there are no tables of organization for the larger units of the Motor Transport Corps, a Supply Train is composed of a headquarters motor command and not less than two or more than six motor-transport companies.

So much space has been devoted in the newspapers and magazines to the exploits of the combatant arms of the service that the public has heard little, if anything, of the less spectacular but no less arduous and important work of the men who wore the purple hatcords of the M. T. C.

It was their endurance and resourcefulness which made possible the transfer by road to the St. Mihiel and Argonne sectors, in nineteen days, of more than half a million men, and this in spite of the unprecedented congestion as a result of the preparations in progress for the great offensives. It was the tireless, iron-hard drivers of the M. T. C. who got forward the food for the men and the food for the guns. It was

the despatch-riders of the corps who, jeering at death, delivered the vital messages which were intrusted to them, tearing down the steel-swept, shell-pocked roads at express-train speed on their roaring motorcycles. No mud was too deep, no shell-storm too violent, no road too dangerous to stop the men of the M. T. C. They went wherever their wheels could find traction—and in some places where they could not. They did not possess so much as a bowing acquaintance with either fatigue or fear. They were the newest corps in the army and they made their own traditions. They were as unconventional in their methods of doing things as the old-time army teamster, the stage-coach driver, and the pony-express rider, whose qualities they have inherited and whose lineal descendants they are. When in doubt they stepped on the accelerator, for the motto of the Motor Transport Corps is "*Get There!*"

X

MENDERS OF MEN

BENEATH the crest of the British Royal Artillery appears the word "*Ubique*"—"Everywhere." It is a motto which might more fittingly be applied to the Medical Department of our own army, however, for that corps has its representatives in every branch of the service—on land, afloat, and in the air. It directed the designing and production of our first gas-masks and from it was drawn the nucleus of our original Gas Defense Service. It provided the medical staffs for the hospital ships and for the army transports. By means of the ingenious system of tests which it devised, it selected our flying-men, determined on the form of aviation work for which they were mentally and physically fitted, and, by a system of unceasing observation, kept them constantly in condition to fight the Boche in the skies. It organized an ambulance service which won the admiration of the world. No battery or battalion went into action without its quota of medical officers, who shared all the perils and privations of their comrades of the line and worked longer. Only two units in the American Army were granted by the French the coveted distinction of wearing the *fourragère:* one of them was an Air Service squadron, the other a unit of the Sanitary Corps of the Army Medical Department. Our medical officers were actually the first in the field and the first to

sustain wounds; the first American killed after the declaration of war was a medical officer.

A list of the Medical Department's activities would include the Dental Corps, the Sanitary Corps, the Veterinary Corps, the Nurse Corps; laboratories for the study and prevention of infectious diseases; organizations for the isolation and the special care of the tuberculous, the insane, the victims of war neuroses; convalescent centres and sanatoria; a division of psychology for gauging the mental capabilities of the army's enlisted personnel; a division of physical reconstruction for the rehabilitation of the sick and wounded; a hospital division which planned and equipped hospitals to meet the constantly increasing needs of the army; a motion-picture industry which enabled the staffs of the various hospitals to see depicted on a screen the latest methods of surgery and medicine and which also illustrated to the soldier the danger of breaking sanitary regulations; the publication of a chain of hospital papers to strengthen the morale of the soldier patients; a system, working in co-operation with the War Risk Insurance Bureau and the Adjutant-General's Office, designed to expedite the settlement of war claims, and a remarkable statistical classification of the sick and wounded, including a complete medical history of each individual case. To this array of extraordinary activities must be added, of course, the features usual to any well-organized medical department: services of internal medicine and surgery working in the closest harmony in every hospital unit; divisions of head surgery (including eye, ear,

nose, and throat), orthopedics, urology, and Roentgenology; and finally that vast organization for the care of the wounded whose operations began with the stretcher-bearers out in No Man's Land and ended only when the men had passed out of the great general hospitals in the homeland with the wound-chevrons on their sleeves.

When, in the past, we have been suddenly confronted by the necessity of making war, we have had to do our organizing after the beginning of hostilities. And, though the titanic conflict had been in progress for more than two years and a half before we entered it, we ran true to form, being as unprepared for war from a medical standpoint as we were from an ordnance, an artillery, or an aviation, point of view. Barring the superficial experience gained by some of our medical officers during the mobilization on the Mexican border, our medical preparations were all made after war had been declared. This unpreparedness was not the fault of the heads of the Medical Department, mind you; it was not due to carelessness or lack of foresight, but was, instead, the logical result of a deliberate policy of those who held that to be prepared for war was to invite war. When the war-cloud broke, it became necessary, therefore, to build overnight, and virtually from the ground up, a mammoth and highly complex organization. When war was declared, the Medical Department, including the Medical Corps, the Dental Corps, the Veterinary Corps, and their respective reserves, had barely 700 commissioned officers on duty in the United States and its possessions. Though the

regular Medical Corps included many officers whose achievements had contributed very largely to the prevention of disease and the amelioration of suffering in all parts of the world—it has been said of former Surgeon-General Gorgas that he "made the Canal possible and the tropics habitable"—and though these officers were skilled in preventive medicine, field sanitation, and other phases of the work of the army surgeon, there was, after all, only a handful of them. It became necessary, therefore, to provide, on the instant, not only for an enormously augmented personnel but also for new and unconsidered conditions. An ambulance service had to be organized and vehicles for it had to be designed and manufactured; hospital trains had to be built—there was only one in the United States when the war began; antiseptic methods in field surgery had to be devised as a substitute for the complete surgical cleanliness possible only under peace conditions; a system had to be devised and put in operation which would insure the prompt collection of the wounded on the battle-field and their rapid evacuation; measures had to be taken for the reconstruction of the severely wounded and their training for future efficiency in civil life.

Beginning, as I have already said, with a peace-time personnel of barely 700 officers, and a peace-time organization, the Medical Department expanded as the army expanded, until, when the Armistice was signed, it was serving 4,000,000 American soldiers at home and overseas and had, in addition, spread its safeguards over millions more of the civil population on both sides

of the Atlantic. Several years prior to the war there had been organized a Medical Reserve Corps which included in its membership many prominent physicians and surgeons. The National Guards of the several States also had their respective medical organizations. The Medical Department at the outbreak of the war consisted, therefore, of nine corps: the Medical Corps, the Medical Reserve Corps, the Medical Corps of the National Guard, the Dental Corps, the Dental Reserve Corps, the Dental Corps of the National Guard, the Veterinary Corps, the Veterinary Reserve Corps, and the Veterinary Corps of the National Guard, to which were added before the war had been in progress a month a Medical Corps, National Army, a Veterinary Corps, National Army, a Sanitary Corps, and an Ambulance Corps, making a total of thirteen distinct services in the Medical Department. By the act of August 7, 1917, however, all of the above were merged into the Medical Corps, United States Army, thereby greatly simplifying administration. But it was quickly realized that, even by calling to the colors every medical officer in the Reserve Corps and the National Guard, the personnel would still fall far short of the number required to provide for the proper care and treatment of the enormous armies which were rapidly being placed in the field, for already the Secretary of War had made his celebrated remark: "Why stop with an army of 5,000,000 men?" Some conception of the problem confronting the surgeon-general may be had when I explain that the Medical Department was expected to furnish each infantry division with approximately 111

officers and 1,400 enlisted men. In addition, an enormous number of medical officers was required for the camp, base, and general hospitals which were springing up like mushrooms, almost in a night, throughout the land. In order to obtain these officers it became necessary, therefore, to appeal to the medical profession of the United States and to the various medical societies, the American Medical Association taking a particularly energetic and enthusiastic part in the work of recruiting. The response of the medical men of America was as prompt as it was gratifying. Specialists whose names were as familiar to the public as those of Cabinet officers and who for a single operation received fees equal to the annual salary of an ambassador; obscure country practitioners who made their daily rounds in mud-bespattered buggies and who, as often as not, received their pay—when they received it at all—in produce; prosperous middle-aged physicians with established and lucrative city practices; struggling young internes; lecturers on medicine and surgery at universities and colleges, put aside their private affairs and offered their services to the nation. So universal was the response, indeed, that numerous communities found themselves facing the prospect of being wholly without medical attendance, for all their physicians were in or were trying to get into khaki.

The same patriotic enthusiasm was shown by the dental profession. At the outbreak of the war there were only 86 dental officers in the Regular Army, this number being based upon the ratio of one dentist to each thousand enlisted men. And, though the im-

portance of a clean, healthy mouth was fully recognized as being essential in maintaining the health of the individual soldier, no Dental Reserve Corps existed at this time. It was evident from the very beginning, therefore, that, in order to care for the teeth of millions of fighting-men, it would be necessary to strain to the very limit the resources of the dental profession. Moreover, before the war had been in progress half a year, it was found necessary to raise the authorized quota of one dentist to every thousand men to one dentist to every 500 men. But the dentists lagged not a whit behind their fellows of the medical profession, so that when Germany threw up her hands and cried "Kamerad!" there were 6,284 officers in the Dental Corps.

When the Secretary of State intimated to the German Ambassador that his immediate departure for the Fatherland would cause no tears, there were barely 400 members of the Army Nurse Corps, 170 of whom were reserve nurses, having been called into active service as a result of the mobilization on the border. Yet when the war ended, the corps carried on its rolls the names of 21,480 nurses, nearly half of whom were serving overseas. As long as a veteran of the Great War lives, the work of these young women will be referred to with something akin to reverence. They displayed a courage, self-sacrifice, and devotion beyond all praise. Among them were capable, experienced executives who wore on the breasts of their trim blue jackets ribbons showing that they had seen previous service in Cuba, in the Philippines, and on the Mexican border.

Others, hundreds upon hundreds of them, came from the hospitals of the larger cities. But by far the greater number of them were graduate nurses who left assured and lucrative private employment for the fatigues, the discomforts, and ofttimes the dangers, of army work. Nurses with wide executive experience were brought into the service as chief nurses of the great army hospitals, some of which had from 300 to 600 nurses on their staffs while the influenza epidemic was at its height. Their work in this emergency requires no comment, for they were untiring in their efforts, taking no heed of the number of hours they worked and frequently staying at their posts until they dropped from exhaustion. During the epidemic 127 nurses died in this country and 35 overseas from influenza or pneumonia resulting from it. Though a number of American nurses have been decorated by foreign governments, our own government has seen fit to recognize the heroism of only four: Miss Beatrice McDonald, who received the D. S. C. for staying by her patients when the hospital in which she was on duty was bombed by German airmen, though severely wounded herself, Miss Helen G. McClelland, Miss Isabelle Stambaugh, and Miss Julia Stimson, who received the D. S. M.

Meanwhile the enlisted personnel had increased enormously. At the outbreak of the war there were in the Medical Department approximately 6,900 men. During the nineteen months of hostilities this force steadily expanded, the recruits including medical students, pharmacists, and others of a medical turn of mind. Not every one in the corps had had experi-

ence in medicine or kindred subjects, however; the chief orderly at the hospital in which I was in France had been one of the editors of *Vanity Fair*, another had been engaged in the importing business, and one of the enlisted men at Fort McHenry Hospital, Baltimore, was a motion-picture actor whose features are known to "movie" fans all over the United States. The Medical Corps reached its maximum strength in November, 1918, when its records showed a total of 264,181 officers and men. Thus it will be seen that the personnel of the Medical Corps alone at the close of the Great War was much greater than that of the entire Regular Army before the beginning of hostilities.

The Medical Corps naturally divides itself into two main branches: the Division of Surgery and the Division of Internal Medicine. The latter, as its name indicates, deals almost entirely with non-surgical diseases and conditions; in other words, medicine as distinguished from the knife. One of the principal functions of the Division of Internal Medicine consisted in obtaining, training, if necessary, and assigning to duty in the various hospitals and camps expert examiners in diseases of the heart and lungs, these officers being charged with the duty of determining the fitness of recruits for military service and their condition on discharge, with special reference to heart disease and tuberculosis. This latter phase of their work assumed such important proportions, however, that it was eventually taken over by a separate division. Another function of the division was to obtain mature and highly trained internists of long experience

to serve as Chiefs of Medical Service in base and general hospitals, these officers, who included many of the ablest physicians in the United States, being responsible for the professional care of all medical patients. For a time a school was maintained to train these medical chiefs, practically all of whom were fresh from civil practice, in the details of army-hospital administration. Younger men, usually with little or no hospital experience and, therefore, less highly qualified, were assigned to serve under the medical chiefs as ward surgeons in direct charge of sick soldiers. A small number of highly experienced men were also brought into the service as medical consultants, their duties being to visit the various hospitals and to maintain helpful and sympathetic relations between the medical staffs and the surgeon-general in Washington. The above is, of course, merely a hasty sketch of the great work done by the medical internists. The vast majority of them were desperately anxious for service in France and moved heaven and earth to obtain overseas assignments, being bitterly disappointed when they found that the needs of the army required that they should remain on duty in the homeland. By comparison with those of their fellows who were serving within sound and often within range of the guns, domestic service seemed quiet and prosaic. But, as a matter of fact, there was nothing commonplace about it at any time. The nearest approach to it was after the Armistice, when the main impulse and motive for military service, the winning of the war, became a thing of the past. But during the continuance of the war the

medical officer, whether his duties kept him on the firing-line itself, in the camp and base hospitals in the rear, far from the thunder of the cannon, or at the cantonments on this side of the Atlantic, never had reason to complain of his work being monotonous or uninteresting, for every day, almost every hour, indeed, brought new experiences and new problems. I doubt if there is a single officer who wore the uniform of the Medical Corps who will not willingly admit that his army work better fitted him for civil practice and afforded him a deeper understanding of the needs of suffering humanity.

The great and crowded days of the medical internist in the United States came with the influenza epidemic. Thrilling, trying, and tragic was this period. At first in driblets, then in streams which increased with appalling rapidity, the men poured into the hospitals. In civil life a hospital with 250 beds is considered a very considerable institution and one of which the community it serves has reason to boast, yet the great base hospitals, sometimes with as many as 2,500 beds, were literally swamped with new cases, occasionally as many as 1,000 "flu" patients being brought in during a single day. These men had to be cared for and carried through. But how? Not only were there not enough hospitals in the land to hold them, but the medical profession, already drained of its practitioners by the demands of the army overseas, was unable to find enough, or nearly enough, physicians, nurses, and attendants, for the influenza, remember, showed no discrimination, attacking soldiers and civilians alike.

When the epidemic descended upon the cantonments, barracks near the hospitals were taken over by the medical authorities, the well men being evacuated to tents in favor of the sick. In many instances buildings which did not have a stick of furniture in them in the morning were ready to receive patients by mid-afternoon. In the meantime cots, pillows, sheets, and blankets, three or four to each cot, had been moved in. Medicines, glasses, and all the other paraphernalia of modern medicine had been obtained. Fires had been started. Cooks, stoves, cooking utensils, food, and dishes appeared as at the wave of a magician's wand. Medical officers and nurses had been assigned and had reported for duty. The Red Cross and other war service agencies were on hand. Arrangements had been made to care for the clothing and valuables of the patients and a hundred other details had received attention. And all this, mind you, in a few short hours. Surgical officers volunteered for medical service. Officers from the training-camps of the Medical Corps were sent by tens and twenties to help out. Every city, town, and village between the oceans was combed for nurses. There were not enough ambulances to transport the sick, so private motor-cars, taxicabs, even motor-trucks, were pressed into use. The drivers sat at their steering-wheels day and night until they could no longer keep their eyes open. Medical officers were on duty from daybreak until long after midnight, day after day, week after week. Nurses and orderlies kept at their work until they dropped from sheer exhaustion. This was the home equivalent of battle service. No

sterner, no more gallant, resistance to the Hun assaults was ever made by the men on the firing-line in France than the battle which was waged against an equally formidable, equally treacherous, enemy by the men and women who wore on their sleeves the silver chevrons of home service.

The Division of Tuberculosis is one of the four branches of the Division of Internal Medicine, it being the only division that has to do with a single disease. This is due to the fact that tuberculosis is admitted the world over to be the most prevalent disease known, one out of every seven of the earth's inhabitants dying from some form of it. In order to detect the presence and combat the spread in the army of the Great White Plague, the Medical Corps very early in the war took steps to standardize the chest examinations of soldiers, all recruits being examined upon their arrival at the camps according to the standard thus devised by doctors who were specialists in tubercular troubles. These measures resulted in excluding from the army about 80,000 cases of active tuberculosis. Had the methods pursued in former wars been adhered to, a considerable proportion of these would undoubtedly have escaped detection, and, as tuberculosis is a highly communicable disease, thousands of perfectly healthy men would have become infected. Most of these tubercular cases would have had their disease aggravated by field service, and, moreover, the resources of the Medical Corps would have been heavily taxed had it been called upon to treat so large a number of patients. Soldiers who were suspected of having tuberculosis, or who developed

it while in the service, were examined by specialists, who confirmed or rejected the original diagnosis, those who were found to have the disease being immediately sent to special hospitals or sanatoria for treatment. The location of these sanatoria in such recognized and widely scattered health resorts as Asheville, North Carolina, Denver, Colorado, the Catskill Mountains, Arizona, and New Mexico enabled the medical authorities to send the soldier patients to regions which, as experience has taught, promote recovery from the disease, and which were at the same time as close as possible to their homes. Patients sent to these hospitals were not discharged from the service until they were cured or until the maximum improvement had been obtained. Thus soldiers received treatment which few civilians could afford, no multimillionaire being able to purchase better medical attention than that which Uncle Sam gave his boys. As tuberculosis is a chronic disease, and as a certain number of cases will relapse after its progress has apparently been arrested, special efforts were made to teach the patients how to live in order to prevent further retrogression, particular emphasis also being laid on the necessity of observing the sanitary precautions which will prevent the transmission of the tubercular germs from the patient to the members of his family.

Though for a number of years prior to the war there had been a steadily increasing appreciation of the importance of neurology and psychiatry in the organization of a fighting-machine, the theories which had been evolved along these lines were never put into practice,

at least on a large scale, until America's entry into the great conflict, when there was organized the Neuro-psychiatric Section of the Division of Internal Medicine. When the section was created, about fifty neuro-psychiatric officers were commissioned; when the Armistice was signed, this number had risen to nearly 700. The chief function of the section was the exclusion from the army, by means of special tests, of men who, because of mental and nervous diseases, were considered unfit for military service. At first this section was treated with open derision or contemptuous tolerance by certain of the narrow-minded or the prejudiced—for the Medical Corps, like all other branches of the army, is not without its fogies who regard with suspicion anything that is new. The best proof of the success of its work, however, is the fact that it discovered the presence in the army, at home and overseas, of more than 72,000 men suffering from nervous and mental disorders, every one of whom was a potential menace to our success as long as he remained in active service. Thanks to the simple but highly effective tests which the psychiatrists devised, certain men were discovered to be moral perverts; the tests showed that others, if exposed to the strain of battle, probably would have suffered mental collapse, and that still others did not possess a sufficiently developed mentality to understand or to carry out orders. Imagine how grave a menace a single pervert might have proved to the morals of the men with whom he was associated in the intimacy of army life. Picture the danger to the success of a military operation of a single soldier who did

not possess sufficient intelligence to understand the orders which were given him or the courage to carry them out. Such men were of far greater potential danger to the welfare of the army than were those suffering from tuberculosis. By means of the psychiatric tests given at the camps and cantonments, more than 1 per cent of all the men brought into the army by the draft were discovered to be mentally unfit and were at once rejected. On the other hand, many drafted men were found to possess exceptional mental qualifications and were thus marked out for assignments where their special aptitudes would prove of the greatest value, in many cases being recommended for the officers' training-camps. This was the first war in which mental tests have been employed. Men with undeveloped minds, unstable nervous systems, or inadequate self-control are very bad risks for armies. They are unknown quantities and their behavior in moments of stress cannot be relied upon. Such men may cause disaster in action, they are liable to shell-shock, and they are likely to swell the lists of pension claimants. But the psychological tests, though they did not entirely eliminate these dangers, certainly reduced them to a minimum, enabling line-officers to equalize the mental strength of their commands by the reassignment or transfer of men to less exacting duties, or, in the case of those who were actually feeble-minded, securing their discharge from the army and returning them to their homes.

To the Division of Laboratories and Infectious Diseases were assigned the duties of ascertaining the

causes of communicable diseases and of establishing methods for their control. The immensely important work of this division was handled by five sections, as follows: (1) The Section of Laboratories, whose duty it was to furnish and train personnel, supervise the work of the laboratories, and standardize the equipment. (2) The Section of Epidemiology, which followed the progress of disease and recommended measures of control. (3) The Section of Urology and Dermatology, which was specially charged with the treatment of venereal disease. (4) The Section on Combating Venereal Diseases, which elaborated and executed measures for educating the soldier on this subject, for the enforcement of legal measures against immoral conditions, and for venereal prophylaxis or early treatment. (5) The Army Medical Museum, which collected pathological material and other specimens of interest to medical men, the scope of its activities being greatly enlarged by the formation of an organization for collecting material in the field.

The problems handled by the Division of Laboratories and Infectious Diseases were both varied and vitally important in preventing wastage of troops. The view held by the experts of the division that the enteric group of diseases, which wrought such havoc in other wars, could be controlled by typhoid and paratyphoid inoculation and by adequate sanitary measures, was confirmed by the fact that, though typhoid occurred in the devastated and extremely insanitary regions along the Western Front, it never became a serious menace to the American Army. With the prac-

tical elimination of the enteric diseases, the respiratory diseases provided the most important problem for the Medical Department. The most vigorous measures were pursued in studying and attempting to control the incidence and mortality of respiratory diseases, and many facts were ascertained which proved of great value during the period of operations and which, when the lessons to be drawn from them have received sufficient study, will eventually place in our hands more adequate means of control. Epidemic cerebrospinal meningitis is another disease which always has to be feared when troops are mobilized. Infection is transmitted by the discharges from the respiratory passages, usually being disseminated by "carriers," who spread the disease without having it themselves. In order to detect these "carriers," any one of whom might unintentionally create as much havoc as an enemy agent in a munitions plant, hundreds of thousands of men were examined, our knowledge of the methods by which the disease is transmitted being thereby greatly increased. The problem presented by the venereal diseases has always been of vital interest to all armies and the fight against this class of infections has been vigorously waged in the American Army for many years. With the passage of the Draft Act it became evident that it would be necessary to extend the fight to the civilian population not only because it was a source of infection of the army but in order to diminish the occurrence of these diseases among drafted men. To accomplish this a close alliance was formed between the Section on Combating Venereal Diseases of the Medical Department and the

FIELD-HOSPITAL.

AN INFECTIOUS WARD.

CLEAR, FILTERED, DISINFECTED WATER.
Complete water-purification plant and laboratory on truck, known as the "steri-lab."

WATER STATION ON THE WESTERN FRONT.
The hose of a "steri-lab" can be seen in the foreground.

War Department's Commission on Training Camp Activities. The methods pursued in preventing venereal diseases aimed, first, at diminishing exposure to infection, and, second, at giving medical treatment to soldiers who have been exposed in order to prevent the development of the disease. One of the most immediately effective measures in preventing exposure was the repression of prostitution and its ally, the liquor traffic, in the neighborhood of army camps and to a lesser degree throughout the country. The surgeon-general assigned specially qualified officers of the Sanitary Corps, mostly lawyers, to the Law Enforcement Division of the Commission on Training Camp Activities, with orders to see that the federal and local laws against prostitution and liquor-selling were rigidly enforced. The results exceeded all expectations. In a year and a half about 130 red-light districts were closed at the instigation of these officers working in the name of the Law Enforcement Division. Street-walking and the connivance of lodging-house and hotel-keepers, taxicab drivers, and others was kept down. Trained women social workers, experts in the management of reformatories and detention houses, and civilian investigators co-operated with the military authorities in the work. Seven hundred and fifty cities and towns were investigated and a thorough clean-up was made in 453. As a result of this work, *it is estimated that to-day not more than five openly recognized red-light districts remain in the whole United States.* It has repeatedly been asserted that military life is conducive to immorality and that the army reeks with venereal diseases. This

charge is effectually disposed of by the statement that of a total of approximately 225,000 cases of venereal disease found to exist in the army, 200,000 were contracted before enlistment.

The Division of Surgery is subdivided into sections of General Surgery, Orthopedic Surgery, Head Surgery, and Genito-Urinary Surgery. In each of the forty-five army hospitals in the United States a surgical service is maintained, the chief surgeon and his assistants having practically the same freedom of judgment in deciding upon the kind of treatment that is to be pursued that they would exercise in civilian institutions. To some extent, however, the matter of treatment is governed by the rules laid down in the Army Medical Manual and the regulations established by the Surgeon-General's Office. Thus, each month a duplicate of the record of every operation performed, a list of the patients who have died and the reasons for their deaths, and a list of the supplies used by the surgical service must be sent to Washington. In addition, the hospital must report upon the number of patients received from overseas and the character of their injuries, and the number of cases of peripheral nerve, empyema, fractures, osteomyelitis, etc., which are in the hospital, together with the classification of the stage of the disease, that is, whether it is improving, whether it is stationary, or whether it will require operation. In this way the Division of Surgery is enabled to maintain a supervision over the operation of each hospital without interfering with its actual workings. In other words, the surgical service is permitted to exercise its

own judgment untrammelled and without interference, but it must render a faithful report of all its doings. These monthly returns are carefully scrutinized in Washington and the work of the entire surgical personnel is carefully watched and card-catalogued. Monthly reports from the various commanding officers and from consultants, as well as information picked up here and there, are entered on these cards, so that no officer can remain for any length of time in the surgical service without the department knowing exactly what he is doing and having a very accurate estimate of his ability.

When war was declared, the army possessed in the United States two hospitals for general cases, one for tuberculosis, one for rheumatism, and 113 post hospitals, with a total capacity of 6,665 beds. In order to meet the anticipated needs of our great new armies a vast programme of hospital construction was started in August, 1917, and, though it was greatly curtailed after the sudden collapse of the German war-machine, by March, 1919, the Medical Department had at its disposal in the United States alone a total of 130,564 beds. In other words, the capacity of our army hospitals was increased 1,850 per cent in twenty months—a record which is, I imagine, without parallel in the history of medicine. The total number of medical officers, nurses, and enlisted men on duty in these hospitals during the period of the war was equal to the population of Albany, New York, and the number of cases which were treated—2,000,000 in all—was equivalent to the total population of Chicago. These

gigantic hospitals, with their cool, clean wards, their ridge ventilation, their wide corridors, their elaborate heating, lighting, water, and fire-fighting systems, are not surpassed by any civil hospitals of their size in the world. To realize this, one has only to visit them. Indeed, it is not the slightest exaggeration to say that the American soldier received the most expensive kind of medical treatment, in hospitals of the finest type, at the hands of physicians and surgeons many of whom had given up princely incomes and leisurely lives in order to work eighteen hours out of the twenty-four at a captain's or major's pay.

It did not take the Medical Department many months to realize that it not only had on its hands thousands of sick and wounded soldiers but it also had the great American public—and the public required the most careful and tactful handling. Before we had been at war a year every conceivable sort of rumor in regard to the way in which the men in the hospitals were being treated was making the rounds. It was whispered that they did not get enough to eat, that they were not properly clad, that the physicians played poker and the nurses danced while their patients lay dying, that out-of-date methods of treatment were the rule, that the medical officers were incapable or overbearing. No rumor seemed too fantastic to receive credence. One woman alighted from her limousine at the entrance to the Walter Reed Hospital in Washington and asked to be shown the "basket cases." Upon being asked by the puzzled attendants what she meant, she explained that she wished to see the soldiers who had

lost both legs and arms, and who, she understood, were kept in baskets! And she was quite frankly sceptical when assured that neither at Walter Reed nor at any other military hospital in the United States was there a soldier who had lost both of his legs and both of his arms. In order to combat such ridiculous and harmful stories, to keep the public informed of the splendid treatment which the soldiers were receiving, and to cheer up the depressed and lonely soldiers themselves, the Publicity Section of the Surgeon-General's Office established a series of hospital papers which covered the entire country. *The Come-Back*, edited and published at the Walter Reed Hospital, Washington, D. C., jumped in one issue to the ranks of the big dailies and steadily held its place in everything—news, editorials, cartoons, advertising, and circulation—that makes a successful newspaper. *The Right About*, published by the patients of Debarkation Hospital No. 3, located in the former Greenhut store in New York City, soon ran up a circulation of more than 50,000—at five cents a copy, too. Among the other papers was *The Trouble Buster*, published at Fort McHenry Hospital, Baltimore; *The Ward Healer*, at General Hospital No. 12, Biltmore, North Carolina; *The Pill Box*, at Debarkation Hospital No. 1, Ellis Island; *The Reclaimer*, General Hospital No. 34, East Norfolk, Massachusetts; *The Stimulant*, General Hospital No. 19, Lakewood, New Jersey, and a score or more of others with equally amusing names. The joyous, humorous, American spirit of these papers set a fashion of good cheer and sportsmanship among the

patients, their attitude being characterized by the slogan shouted from the top of the first page of one of them: "The Come-Back chirps so loud that nobody has the nerve to growl."

Even before the first of the constantly growing streams of wounded began to trickle home from France, it was recognized by the Medical Department that a system must be devised and put into operation whereby these men, instead of being mended and turned loose to shift for themselves as best they could, must be carried along, receiving treatment and pay, until they had attained the maximum degree of physical and functional restoration. For a quarter of a century after the close of the Civil War the streets of American cities were filled with disabled men who eked out their scanty pensions by selling shoe-laces, pencils, novelties, or by begging, because no intelligent measures had been taken to refit them for their former occupations or to fit them for new ones. It was determined that this condition must not occur again. The plan for physical reconstruction of the soldiers, as ultimately adopted, was simple, direct, and effective. It involved primarily the establishment of an administrative organization known as the Division of Physical Reconstruction, divided into departments of physiotherapy and education. Certain subdepartments were also made necessary by the special requirements of those soldiers who had lost their speech, their hearing, or their sight. The sympathy and interest aroused by this work throughout the country quickly drew into it as officers or advisers many men eminent in those walks of life

which best fitted them for the exacting duties demanded by this service. The work of physical reconstruction has been eminently successful in its effect upon the disabled soldier, bringing him to a realization that, however great and disheartening his impairment, he might hope for usefulness, happiness, and self-support in the future, and in many cases leading to the adoption of a new and better vocation and a better standing in life. I knew one man who had had both legs blown off by a shell at Château-Thierry. He was a young, fine-looking, exceptionally intelligent fellow, but, with the prospect of spending the rest of his days in a wheel-chair staring him in the face, he had sunk to the depths of misery and discouragement. But one day one of the experts of the reconstruction service sat down beside his bed, offered him a cigarette, and started a conversation.

"What did you do before you went into the army?" the reconstructionist inquired.

"I was a carpenter," the man answered. "Made good money, too. But I guess the only thing I'll be good for in the future will be peddling shoe-laces," he added bitterly. "No one wants a legless man."

"Ever have any other occupation?"

"No. I always wanted to be an architect, but my people didn't have the money to send me to college, so I went to work after I finished high school."

"Would you like to take up architecture now if you could get the training?" the reconstruction expert asked.

"Would I?" the soldier gasped incredulously.

"Would I? Say, friend, what's the use of hitting a fellow when he's down and out?"

"You're not down and out," was the cheery answer. "Not by a damned sight! If you want to be an architect, Uncle Sam is ready to give you a chance. He will give you an education, and pay you while you are getting it, and then he will get you a job. Don't get the idea into your head that he has forgotten what he owes you boys who have fought for him."

The last time I saw that soldier he had already commenced his architectural education.

"If he keeps on as well as he has begun," one of his instructors told me, "he will make several times as much money without any legs as he did with them."

The educational work starts at the bedside as soon as the patient feels the need of some activity or diversion. Each patient is treated as an individual, an educational activity being selected for him which will have the greatest curative effect and will at the same time present the greatest interest and incentive because of the future usefulness which it holds out to him. Simple crafts, light, desultory, and diverting, gradually give place to more exacting, more purposeful studies and occupations. For one man the series may be bead-work, mechanical drafting, wood-shop, carpentry; for another, knitting, basketry, penmanship, and accounting; for the illiterate it may be some textile project followed by instruction in reading and writing. Since the work began, 75,000 men have been enrolled in some form of educational work in fifty hospitals. Many have regained control of palsied muscles, limbered up stiff-

ened joints, revived dulled mental sensibilities, steadied shaken nerves, or obtained improved physical tone by the application of these methods. To thousands the educational service has brought the discovery that, in spite of the handicap of their disabilities, they possess unsuspected ability in certain lines of useful and profitable endeavor, thus substituting hope for despair and showing them the way to a useful and contented future.

M—— was illiterate; in fact, he could not sign the pay-roll or read the simplest orders; he was bedridden with wounds in his shoulder and arm. He came from a remote mountain community, where the need of even a rudimentary knowledge of the three R's was not deemed necessary. For thirty minutes a day for six weeks he studied reading, writing, and arithmetic. When he was ready for discharge from hospital he was able to write short letters, though he found spelling puzzling. In reading he made unusual progress, though his oral inflection left something to be desired. His greatest pleasure was to receive a letter from his brother, who had had five years' schooling but could not write as well as M—— himself, or to write to his mother instead of being compelled to ask the other boys to write his letters for him.

Many of the soldiers are country boys and will go back to farming when they leave the hospital. For them there are courses in farm accounting and work in the gas-engine shop and with the hospital's tractor. Clerks who were unable to obtain promotion because they did not understand stenography and typewriting are learning those branches, and some are taking courses

in the newest systems of cataloguing and bookkeeping. A boy who had lost both legs above the knee became proficient in Spanish in order that he might assist his brother in the management of a ranch near the Mexican border. Others are taught woodworking, gardening, the operation and repair of gas-engines, shoe repairing, oxyacetylene welding, printing, electrical mechanics, lettering, and drawing. One day there was brought into the reconstruction hospital at Colonia, New Jersey, a boy whose hands had been taken off at the wrists. For five weeks he had been fed and cared for by any one who happened to be near. He was helpless and despondent. The able and energetic woman in charge of the educational work in his ward suggested that if a spoon was fastened to the stump of his right arm he would be able to feed himself. At first he said that he couldn't, but she insisted on his making the attempt. The very next day he called to the sergeant who had told him that dinner was ready: "I can wait on myself now." Then he devised a way to light his own cigarettes. Before long they had rigged up a device by which brushes could be fastened to his arms and he was set to work painting toys and boxes. And he did it remarkably well, everything considered. And, what was much more important, he whistled as he worked.

I doubt if any branch of the army did more efficient work in its respective line, and received less credit from the public, than the Veterinary Corps. This lack of appreciation was due, in the first place, to public ignorance of the duties of the corps and of the character of

its personnel. Most people associate a veterinarian with the old-time country horse-doctor, of rough manners and still rougher speech, who was known to every man and boy in the countryside as "Doc." The army veterinarian is a different genus altogether. He is usually as smart in appearance and as well-set-up as any officer of the line; he is more often than not a university graduate, and his methods of treatment are as modern and scientific as those of a surgeon or a medical specialist. The impression also seems to prevail that, as a result of the wholesale motorization of artillery and transport and the enormous use of aircraft, animals played but a small part in the Great War, and that consequently the army veterinarian enjoyed something akin to a sinecure. As a matter of fact, nothing could be further from the truth. Probably you were not aware that when the war ended, the United States Army possessed close to half a million horses and mules—the exact figure was, I believe, about 470,000—and was purchasing hundreds of more daily. Not only was the task of inspecting and supervising the care of this great body of animals an enormous one, but, as a result of the extreme scarcity of horse-flesh—for buyers for the European armies had almost drained the markets of the world before we entered the war—and because of the lack of tonnage, the animals of the A. E. F. were, as a divisional commander expressed it in a general order, "worth their weight in gold."

Prior to 1916 there were only about 75 veterinarians in the entire army, but with the passage during that year of the National Defense Act the number of

veterinarians at the call of the government was materially increased by the creation of the Veterinary Reserve Corps. The Veterinary Corps, like other branches of the service, kept pace with the expansion of the army, and when the Armistice was signed it had on duty 2,200 officers and an enlisted force of more than 21,000 men.

When an animal is first led before a purchasing commission its relation to the Veterinary Corps begins. Every horse and mule must be examined by a veterinary officer for soundness and freedom from physical defects before it can be purchased. As soon as the purchased animals have arrived at the various remount depots they become the objects of unceasing attention by the Veterinary Corps, whose duty it is to keep them free from disease and in the highest state of efficiency. This work includes the sanitary inspection of stables, picket-lines, forage and bedding, methods of feeding, watering, grooming, and shoeing, the detection and segregation of communicable diseases and the establishment of proper quarantine regulations, the care and treatment of all sick animals, the operation of veterinary hospitals, the investigation of the cause and cure of equine diseases, and the keeping of records. Another important duty of the corps in France was the prompt evacuation of all wounded animals in order that they might not hinder the mobility of the troops or engage the attention of the men. In order to facilitate the evacuation of sick and wounded animals from the Zone of the Advance, 21 veterinary hospital or-

ganizations—each consisting of 7 officers and 300 men, and each having a capacity of 1,000 sick animals—were trained, organized, and sent overseas. There were also sent to France 2 base veterinary hospitals with a capacity of 500 animals each. Besides this, every cantonment in the United States had its own veterinary hospital, varying in capacity from 200 to 600 animals each. As a result of the scientific methods of sanitation and treatment introduced by the Veterinary Corps, the mortality among animals was enormously reduced (in the early days of the war the British estimated that the average life of a horse in France was only sixteen days), thousands of disabled horses which in former wars would have been shot were evacuated, mended, and sent back to the front for further service, and millions of dollars were saved to the American taxpayer.

Even more important than its care of the animals of the army was the work of the Veterinary Corps in protecting the men by guarding the purity of their meat and dairy supplies. The activities of the Meat and Dairy Inspection Service include the inspection of meats purchased for the use of the army at the time of their receipt, while in storage, and upon issue to troops; inspection of storehouses, refrigerators, and methods of operation in handling food therein; inspection of slaughter-houses, butcher-shops, and packing-houses; ante-mortem and post-mortem inspection for soundness and suitability for human food of animals slaughtered; inspection of cows and dairies providing milk, butter, and cheese for the use of the troops.

Some conception of the extent and importance of the work of the Meat Inspection Service can be had by remembering that when the war ended, the Packing-House Products Branch of the Office of the Director of Purchase and Storage was purchasing for the use of the army an average of from 15,000,000 to 19,000,000 pounds of meat products weekly. And every carcass, if not every pound, had to be inspected and passed by the Veterinary Corps before it reached the mess-tables of the army. That, in spite of the incredible quantities of meat products which had to be purchased for the use of our forces in the field, and the great distances between the abattoirs and the zone of operations, there was no repetition of the "embalmed-beef" scandal which sullied the history of the war with Spain was due to the efficiency and unremitting vigilance of the men who wore on their collars the insignia of the Veterinary Corps.

I am perfectly aware that the medical officers who do me the honor to read this chapter will criticise me for the omissions I have made. And such criticism is justified. I have dismissed such important phases of the work of the Medical Corps as the Division of Surgery with a few paragraphs; to the Dental Corps and the Nurse Corps I have been able to devote but a few lines; the Sanitary Corps, the Ambulance Service, and a score of other branches I have merely mentioned. Of the marvellous work performed by our medical officers in plastic surgery, in bone grafting, in the disinfec-

tion of wounds, in orthopedics, in the treatment of the blind, the shell-shocked, and the insane, I have written nothing—the subject is too great, the space at my disposal too limited to even attempt it. The most that I can hope to do in the limits of a single chapter is to give my readers the same fleeting, cursory view of the achievements of the Medical Department that one obtains of a countryside from an airplane.

If America's losses in the greatest of wars were relatively slight—and they *were* slight when compared with the appalling casualties suffered by most of the other warring nations—the reason is not to be found in the superiority of American strategy, in the ability of American commanders, or in the excellence of American weapons, but in the efficiency, self-sacrifice, and devotion of the officers, nurses, and men who wore the caduceus of the Army Medical Department. And I know whereof I speak, for I have not only visited French, British, Belgian, Italian, even German, hospitals all the way from La Panne to Montfalcone, thus affording me standards of comparison, but I spent nearly three months in an American hospital on the Marne, I came home on an American hospital-ship, and for nearly three months more I was under the care of army medical officers in the United States. In dressing-stations, field, camp, base, debarkation, and general hospitals I have watched the Medical Department at its work, and the first-hand knowledge thus gained gives me the right to assert that it was the most efficient

service of its kind possessed by any army. To its officers and men, and to the devoted women of the Army Nurse Corps, I lift my hat in gratitude and admiration. The American Army and the American people owe them a debt which they can never fully pay.